LAKE CLASSIFICATION REPORT FOR PATRICK LAKE, ADAMS COUNTY

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EXECUTIVE SUMMARY

Background Information about Patrick Lake

Patrick Lake is located in the Town of New Chester, Adams County, WI, in the south central part of Wisconsin. It is reached off of County E as it turns south. Patrick Lake is a mesotrophic seepage lake with good to very good water quality and clarity. It has 50 surface acres, with a maximum depth of 21 feet and a mean depth of 10 feet. In the past few years, the water level in Patrick Lake has been declining substantially. As in the case in all seepage lakes, the water level on Patrick Lake fluctuates naturally with the underground water table, but studies are underway to determine if some other factors may be contributing to the lowering water levels. There is a county park and boat launch at the southeast “corner” of the lake. The lake is managed by the Patrick Lake District, formed in 1981, which has a proposed lake management plan pending before the WDNR at this time.

In both the surface and ground watersheds, the soils are fairly evenly divided between loamy sand and sand. There are small pockets of muck, sandy loam, and silty clay loam.

Loamy sands tend to be well-drained, with water, air and nutrients moving through them at a rapid rate. Runoff, when it occurs, tends to be slow. Loamy sands have little water-holding capacity and low natural fertility, although they usually have more organic matter present than do sandy soils. Both wind and water erosion are potential hazards with loamy sands, as is drought. There are difficulties with waste disposal and vegetation establishment because of slope and seepage.

Sandy soil tends to be excessively drained, no matter what the slope. Water, air and nutrients move through sandy soils at a rapid rate, so that little runoff occurs unless the soil becomes saturated. Although water erosion can be a problem, wind erosion may be more of a hazard with sandy soils, especially since these soils dry out so quickly. There are also draught hazards with sandy soils. Getting vegetation started in sandy soils is often difficult due to the low available water capacity, as well as low natural fertility and organic material. Onsite waste disposal in sandy soils is also a problem because of slope and seepage; mound systems are usually required.

Land Use in Patrick Lake Watersheds

While the surface watershed of Patrick Lake is fairly small, the ground watershed goes east and north of the lake about three miles. Woodlands are the largest land use category in both Patrick Lake watersheds. Since forest floors are often full of leaves, needles and other duff, runoff from forested lands may be more filtered than that from agricultural or residential lands. Residential land use is the second most common land use category in both the Patrick Lake watersheds, especially around the lake itself, where residential land use is most concentrated. This land use category may contribute a significant amount of nutrients to the water from stormwater runoff, mowed lawns, and impervious surfaces. Septic systems may also add to nutrient loading from residential land use. Agricultural land use may contribute significantly to the amount of nutrient loading in a watershed. While only a small part of the surface watershed of Patrick Lake is in agricultural use, the groundwatershed has a much larger portion of its land use in agriculture.

Patrick Lake has a total shoreline of 1.68 miles (8870.4 feet). Much of the shore in the northwest lobe and in the west part of the center lobe of the lake has been left mostly undisturbed. Buildings in these areas tend to be uphill and more than 70’ from the shore. The eastern lobe of the lake is in residential use and park use. Most of the areas in this lobe are flatter than the northwest end. Buildings in this lobe are generally located closer to the shoreline than those on the west part of the lake. 80% of Patrick Lake’s shoreline is vegetated.

A 2004 shore survey showed that most of the shore had an “adequate buffer.” An “adequate buffer” is a native vegetation strip at least 35 feet landward from the shore. However, there were still areas of “inadequate” buffers, mostly those with mowed lawns and insufficient native vegetation at the shoreline to cover 35 feet landward from the water line. There are also several areas of sand bars and some active erosion.

Adequate buffers on Patrick Lake in some places could be easily installed on the inadequate areas by either letting the first 35 feet landward from the water just grow without mowing it, except for a path to the water, or by planting native seedlings sufficient to fill in the first 35 feet or using biologs to protect the shore that are vegetated. Where areas are deeply eroded, shaping, revegetating and protecting the shores will be necessary to prevent further erosion.

Water Testing Results

Between 2004 and 2006, Adams County Land & Water Conservation Department gathered water chemistry and other water quality information on Patrick Lake.

Overall, Patrick Lake was determined to be a mesotrophic lake with good water quality and very good water clarity.

Measuring the phosphorus in a lake system provides an indication of the nutrient level in a lake. Increased phosphorus in a lake will feed algal blooms and also may cause excess plant growth. The 2004-2006 summer average phosphorus concentration in Patrick Lake was 17.3 micrograms/liter. This average is under the 30 micrograms/liter level recommended to avoid nuisance algal blooms. This concentration suggests that Patrick Lake is unlikely to have frequent nuisance algal blooms from excessive phosphorus.

Water clarity is a critical factor for plants. If plants don't get more than 2% of the surface illumination, they won't survive. Water clarity is measured with a Secchi disk. Average summer Secchi disk clarity in Patrick Lake in 2004-2006 was 10.2 feet. This is very good water clarity.

Chlorophyll-a concentration provides a measurement of the amount of algae in a lake's water. Algae are natural and essential in lakes, but high algal populations can increase water turbidity and reduce light available for plant growth, as well as result in unpleasing odor and appearance. The 2004-2006 growing season (June-September) average chlorophyll-a concentration in Patrick Lake was 2.8 micrograms/liter, a low algal concentration.

Patrick Lake's surface water hardness of 109 milligrams/liter was considerably below the overall hardness average for natural lakes in Adams County of 135.3 milligrams/liter of Calcium Carbonate, although slightly higher than the 1983 figure of 102.4 milligrams/liter. Hard water lakes tend to produce more fish and aquatic plants than soft water lakes because they are often located in watersheds with soils that load phosphorus into the lake water.

A lake with a neutral or slightly alkaline pH like Patrick Lake is a good lake for fish and plant survival. Natural rainfall in Wisconsin averages a pH of 5.6. This means that if the rain falls on a lake without sufficient alkalinity to buffer that acid water coming in by rainfall, the lake's fish cannot reproduce. That is not a problem at Patrick Lake, since its surface water alkalinity averages 95 milliequivalents/liter. The pH levels from the bottom of the lake to the surface hovered between nearly 7 and 8, alkaline enough to buffer acid rain.

Most of the other water quality testing at Patrick Lake showed no areas of concern. The average calcium level in Patrick Lake's water during the testing period was 24.04 milligrams/liter. The average Magnesium level was 13.74 milligrams/liter. Both of these are low-level readings. Both sodium and potassium levels in Patrick Lake are very low: the average sodium level was 0.85 milligrams/liter; the average potassium reading was .18 milligrams/liter.

To prevent the formation of hydrogen sulfate gas, levels of 10 milligrams/liter are best. A health advisory kicks in at 30 milligrams/liter. Sulfate levels in Patrick Lake are 12.41 milligrams/liter, below the health advisory level, although above the level for formation of hydrogen sulfate. Turbidity reflects water clarity. The term refers to suspended solids in the water column—solids that may include clay, silt, sand, plankton, waste, sewage and other pollutants. Very turbid waters may not only smell and mask bacteria & other pollutants, but also tend to be aesthetically displeasing, thus curtailing recreational uses of the water. Turbidity levels for Patrick Lake were at low levels between 2004-2006.

The presence of a significant amount of chloride over a period of time may indicate that there are negative human impacts on the water quality present from septic system failure, the presence of fertilizer and/or waste, deposition of road-salt, and other nutrients. Chloride levels found in Patrick Lake during the testing period averaged 6.67 milligrams/liter, far above the natural level of 3 milligrams/liter for this region of Wisconsin. This elevation should be investigated.

Nitrogen levels can affect other aspects of water quality. The sum of water testing results for nitrate, nitrite and ammonium levels of over .3 milligrams/liter in the spring can be used to project the likelihood of an algal bloom in the summer (assuming sufficient phosphorus is also present). Patrick Lake's combination spring levels from 2004 to 2006 averaged .09 milligrams/liter, below the .3 milligrams/liter predictive level for nitrogen-related algal blooms. However, the nitrogen level should still be monitored because the growth level of Eurasian watermilfoil, historically the main invasive aquatic plant species in Patrick Lake, has been correlated with fertilization of lake sediments by nitrogen-rich runoff.

Phosphorus

Like most lakes in Wisconsin, Patrick Lake is a phosphorus-limited lake: of the pollutants that end up in the lake, the one that most affects the overall quality of the lake water is phosphorus. The amount of phosphorus especially affects the frequency and density of aquatic vegetation and the frequency and density of various kinds of algae, as well as water clarity and other water quality aspects.

The total phosphorus (TP) concentration in a lake is considered a good indicator of a lake's nutrient status, since the TP concentration tends to be more stable than other types of phosphorus concentration. For a natural lake like Patrick Lake, a total phosphorus concentration below 25 micrograms/liter tends to result in few nuisance algal blooms. Patrick Lake's growing season (June-September) surface average total phosphorus level of 17.3 micrograms is slightly under that limit, suggesting that phosphorus-related nuisance algal blooms should be infrequent.

Land use plays a major role in phosphorus loading. Currently, the most phosphorus loading is coming from noon-irrigated agriculture in the surface watershed and from the ground watershed. Residential inputs are third in phosphorus loading in the surface watershed. Some phosphorus deposition cannot be controlled by humans. However, some phosphorus (and other nutrient) input can be decreased or increased by changes in human land use patterns. Practices such as shoreland buffer restoration along waterways; infiltrating stormwater runoff from roof tops, driveways and other impervious surfaces; using no phosphorus lawn fertilizers; and reducing phosphorus input to and properly managing septic systems will minimize phosphorus inputs into the lake. Such practices need to be implemented in all of the Patrick Lake Watershed in order for a significant impact on phosphorus reduction to occur.

Reducing the amount of input from the surface and ground watersheds results in less nutrient loading into the lake itself. Under the modeling predictions, reducing phosphorus inputs from human-based activities even 10% would improve Patrick Lake water quality by .7 to 4.9 micrograms. A 25% reduction would save 1.75 to 12.25 micrograms/liter, substantially under the 30 micrograms/liter recommended to avoid nuisance algal blooms. These predictions make it clear that reducing current phosphorus inputs to the lake are essential to improve, maintain and protect Patrick Lake's health for future generations.

Aquatic Plant Community

In 2005, a qualitative aquatic plant survey was done on Patrick Lake by staff from WDNR and Adams County Land & Water Conservation Department. Abbreviated aquatic plant surveys, using different sampling methods, were conducted in 1983, 1993 and 2004.

The 2005 aquatic plant survey found that the Patrick Lake aquatic plant community colonized approximately three-quarters of the entire lake area to a maximum rooting depth of 13 feet. Within the important shallow water littoral zone, 100% of the sites were vegetated. The 0-1.5ft depth zone supported the most abundant aquatic plant growth. The aquatic plant community is characterized by high quality, good species diversity, an average sensitivity to disturbance and a condition closer than average to an undisturbed condition.

Of the 17 aquatic species found in Patrick Lake in 2005, 15 were native aquatic plants. 2 species were macrophytic-algae (*Chara* and *Nitella*). In the native plant category, 3 were emergent plants, 3 were floating-leaf rooted plants, and 9 were submergent species. The exotic invasive found in 2004, *Myriophyllum spicatum* (Eurasian Watermilfoil), wasn't found in 2005, most likely because chemical treatment in May 2005. The dominant and common plant species were found throughout the lake except one. *Potamogeton richardsonii* was found only in the south half of the lake. Filamentous algae were found at 34.04% of the sample sites.

Since Eurasian Watermilfoil has had a high frequency of occurrence in the past, the Patrick Lake District will need to closely monitor its possible recurrence. Its tenacity and ability to spread to large areas fairly quickly make it an ongoing danger to the diversity, habitat value and equality of Patrick Lake's aquatic plant community. Also, Curly-Leaf Pondweed, another aquatic invasive plant, has been found previously in Patrick Lake. Monitoring for its recurrence should also occur.

Critical Habitat Areas

Wisconsin Rule 107.05(3)(i)(I) defines a "critical habitat areas" as: "areas of aquatic vegetation identified by the department as offering critical or unique fish & wildlife habitat or offering water quality or erosion control benefits to the body of water. Thus, these sites are essential to support the wildlife and fish communities. They also provide mechanisms for protecting water quality within the lake, often containing high-quality plant beds. Finally, critical habitat areas often can provide the peace, serenity and beauty that draw many people to lakes. Three areas on Patrick Lake were determined by a team of lake professionals to be appropriate for critical habitat designation.

Area PA1 extends along approximately 800 feet of the shoreline. 70% of the shore is native herbaceous vegetation; 23.3% of the shore is cultivated lawn; the remaining shore is hard structure. There are downed logs in the water that provide fish and wildlife cover. Filamentous algae were found in this area. There is a moderate level of human disturbance at this area. No threatened or endangered species were found here. Aquatic vegetation at this site included 1 emergent species, 2 species of floating-leaf rooted plants and 7 species of submergent aquatic plants. Curly-Leaf Pondweed, an exotic invasive plant, was found in this area. Most of the aquatic vegetation in this area has multiple uses for fish and wildlife. Because this site provides all three structural types of vegetation, the community has a diversity of structure and species that supports even more diversity of fish and wildlife.

Area PA2 extends along approximately 1000 feet of the shoreline. 25% of the shore is wooded; 10% has shrubs; 45% is native herbaceous cover. The remaining shore is cultivated lawn and hard structure. Large woody cover is common in the shallow water for habitat. Maximum rooting depth in CR2 was 13 feet. No threatened or endangered species were found in this area. One exotic invasive, *Potamogeton crispus* (Curly-Leaf Pondweed), was found in this area. *Myriophyllum spicatum* had been found previously here. Most of the area had filamentous algae, especially near the shores. The plant-like algae, *Chara* spp was abundant in this area. There is a shortage of emergent plants in this area. One floating-leaf rooted plant species was found. The remaining 6 aquatic plant species were all submergents.

Area PA3 extends along approximately 1650 feet of the shoreline. Sediment includes marl, muck, peat, sand, silt and mixtures thereof. 6.7% of the shore is wooded; 5% has shrubs; 85% is native herbaceous cover—the remaining is cultivated lawn. Large woody cover is present in shallow water for fish and wildlife cover. Scenic beauty in part of the area is lessened due to the human development. Maximum rooting depth in PA3 was 7 feet. No threatened or endangered species were found in this area. *Chara* spp and filamentous algae were present in area PA3. Only one emergent species found in this area. One floating-leaf rooted plant was present here. 5 species of submergent aquatic species were found here. *Potamogeton crispus* was common here. Another exotic invasive, *Myriophyllum spicatum* (Eurasian watermilfoil), was previously found in this area.

<u>Fish/Wildlife/Endangered Resources</u>

WDNR records show that Patrick Lake had a long history of fish winterkills, back to 1936, until an aeration system was installed in 1974. A chemical eradication of fish in the lake in 1962 revealed only yellow perch, black bullheads and bluegills. For reason unknown, largemouth bass & northern pike that had been stocked previously had apparently not survived. After the 1962 kill, stocking started again in 1963, and later inventories show that the lake included northern pike, largemouth bass, crappie and bluegills. Whatever the previously problem was for non-survival, apparently it didn’t continue after the 1962 chemical eradication. Since 1963, fish inventories have found that largemouth bass continued to survive in the lake, as well as pumpkinseed, black bullhead, perch and bluegills. Pike continue to survive, but are scarce. There are no reported endangered resources in either of the Patrick Lake Watersheds.

Conclusion

Patrick Lake is a natural lake impacted substantially by significant dense plant growth and possible phosphorus loading from the lake bed. The lake has also been suffering from lowering lake levels the past few years, which have further disturbed the aquatic community in the lake. The Patrick Lake District will need to monitor the lake for water quality, aquatic plant growth and invasive species, as well as regularly review and update its lake management plan in order to address the management issues in a logical, cohesive manner.

RECOMMENDATIONS

Lake Management Plan

The Patrick Lake District has submitted a proposed lake management plan to the Wisconsin Department of Natural Resources for approval. Once the plan is approved, the Patrick Lake District will need to regularly review and update its lake management plan in order to address the management issues needed. The plan needs to always address the following: aquatic plant management; control/management of invasive species; wildlife and fishery management; watershed management; shoreland protection; critical habitat protection; water quality protection; inventory & management of the larger watershed.

The District should consider keeping its Citizen Lake Advisory Group active to assist it. This group could be used to gather information for the district and report to the District Board.

Watershed Recommendations

Results of the modeling certainly suggest that input of nutrients, including phosphorus, and the presence of high-phosphorus lake sediments are factors that need to be explored for Patrick Lake. Therefore, it is recommended that both the surface and ground watersheds be inventoried, documenting any of the following: runoff from any livestock operations that may be entering the surface water; soil erosion sites; agricultural producers not complying with nutrient management plans and/or irrigation water management plans. If such sites are documented, steps for dealing with these issues can be incorporated into the lake management plan as needed.

It would also be helpful to conduct sediment core sampling in areas that might be considered for dredging. This will assist in determining the parameters of the cost of any proposed dredging, since any sediment that has elevated levels of materials such as arsenic may need to be disposed of as hazardous waste, thus increasing costs.

The Patrick Lake District should consider approaching the WDNR or conservancy organizations to explore putting the undeveloped areas of the lake into a permanent easement or non-development area to assure that those areas won't be changed in a way that would degrade water quality of the lake.

Shoreland Recommendation

All lake residents should practice best management on their lake properties, including keeping septic systems cleaned and in proper condition, eliminating the use of lawn fertilizers, cleaning up pet wastes and not composting near the water.

Aquatic Plant Management Recommendations

1) There should be renewed and expanded involvement of lake citizens in water quality monitoring and invasive species monitoring through the Citizen Volunteer Lake Monitoring Program. The Lake District should also have volunteers actively involved in the Clean Boats, Clean Waters program to assist in preventing the introduction of other invasives into the lake and in boater education.

(2) Although chemical treatments have long been used on Patrick Lake, consideration should be given to reduce the chemical uses and consider adding other methods to its aquatic plant management plan, especially if the two invasives previously known to have occurred in the lake return. This could include increases the amount of mechanical harvesting done, using targeted harvesting for Eurasian watermilfoil management. Mid-summer harvesting could focus on the other goals of the harvesting plan. The early-season cutting should be conducted when mifloil is almost to the surface and cut near the sediment level without disturbing the sediments to stress the milfoil and open up the top canopy to allow light penetration into the water for the native species. The late-season harvesting would be conducted in September when native plants are going dormant and focus on cutting the milfoil before it autofragments in the fall.

(3) Continued larger scale use of chemicals is contraindicated because it is believed that the decaying plant material adds to the internal loading in the lake, further increasing the amount of aquatic plant growth and filamentous algae presence.

(4) If harvesting occurs, harvested plant tissue should be tested annually to determine how much phosphorus is being removed through the harvesting program. Keep track of amount of aquatic vegetation removed through harvesting.

(5) Since Patrick Lake has denser aquatic plant growth than is optimum for a balance fishery (no more than 85% aquatic plant coverage), the District should implement a harvesting plan to reduce cover and open areas for fish. Dense vegetation removal by hand in shallow water can be removed to a maximum 30 feet channel out of 100 feet of shoreline at each property.

(6) Natural shoreline restoration and erosion control in some areas are needed. Biological shoreline restoration is preferred. If trees fall due to continued erosion, large portions of the banks will fall with them. The areas where there is undisturbed vegetated shore should be maintained and left undisturbed for water quality & habitat protection.

(7) To protect water quality, a buffer area of native plants should be restored on those sites that now have traditional lawns mowed to the water's edge. This is especially important because about one-fifth of the shoreline is currently impacted by disturbed shores.

(8) Buffers already installed around the lake should be maintained in their current condition.

(9) Stormwater management on the impervious surfaces around the lake is essential to maintain the high quality of the lake water

(10) No lawn chemicals should be used on properties around the lake. If they must be used, they should be used no closer than 50 feet to the shore.

(11) Septic systems around the lake should be regularly inspected and maintained properly. This can be handled through the county, through the town or through the lake district itself.

(12)The Patrick Lake District should continue to apply for grants from the Wisconsin Department of Natural Resources to help defray the cost of aquatic plant management and other management plan activities.

(13) Patrick Lake residents should identify, cooperate with and participate in watershed programs that will reduce nutrient and sediment inputs.

(14) Critical habitat areas were formally determined in 2006 and a report released in 2007. The lake management plan should include recommendations for preserving these areas in its update.

(15) The Patrick Lake District should make sure that its lake management plan takes into account all inputs from both the surface and ground watersheds and addresses the concerns of this lake community.

Critical Habitat Recommendations

(1) Maintain current habitat for fish and wildlife.
(2) Do not remove fallen trees along the shoreline nor logs in the water.
(3) No alteration of littoral zone unless to improve spawning habitat.
(4) Seasonal protection of spawning habitat.
(5) Maintain snag/cavity trees for nesting.
(6) Maintain wildlife corridor in some areas and increase corridor in more developed areas.
(7) Establish shore buffers of native vegetation in areas now in cultivated lawn.
(8) Maintain no-wake zone.
(9) Protect emergent vegetation.
(10) Removal of submergent vegetation only and only for navigation in narrow channels.
(11) Seasonal control of Curly-Leaf Pondweed and Eurasian Watermilfoil if they reoccur.
(12) No use of chemicals for control of native vegetation.
(13) Minimize aquatic plant and shore plant removal by limiting removal to 30' wide access/viewing corridor. Leave as much vegetation as possible to protect water quality and habitat.
(14) Use best management practices in undeveloped areas on shoreline properties.
(15) No use of lawn products on shoreline properties.
(16) No bank grading or grading of adjacent land.
(17) No additional pier construction or other activity except by permit using a case-by-case evaluation.
(18) No installation of pea gravel or sand blankets.
(19) No bank restoration unless the erosion index scores moderate or high. Enforce 30'per 100' of shorefront for access corridor regulations.
(20) If the erosion index does score moderate or high, bank restoration only using biologs or similar bioengineering, with no use of riprap or retaining walls.
(21) Placement of swimming rafts or other recreational floating devices only by permit.
(22) Maintain buffer of shoreline vegetation where there is currently a buffer.
(23) Maintain aquatic vegetation buffer in undisturbed condition for wildlife habitat, fish use and water quality protection.
(24) Post "exotics alert" sign at boat ramp.

LAKE CLASSIFICATION REPORT FOR PATRICK LAKE, ADAMS COUNTY

INTRODUCTION

In 2003, The Adams County Land & Water Conservation Department (Adams County LWCD) determined that a significant amount of natural resource data needed to be collected on the lakes with public access in order to provide it and the public with information necessary to manage the lakes in a manner that would preserve or improve water quality and keep it appropriate for public use. In some instances, there was significant historical data about a particular lake; in that instance, the study activities concentrated on combining and updating information. In other instances, there was no information on a lake, so study activities concentrating on gathering data about that lake. Further, it was discovered that information was scattered among various citizens, so often what information was actually available regarding a particular lake was unknown. To assist in updating some information and gathering baseline information, plus centralize the data collected, so the public may access it. The Adams County LWCD received a series of grants from the Wisconsin Department of Natural Resources (WDNR) from the Lake Classification Grant Program.

Objectives of the study were:

- collect physical data on the named lakes to assist in assessing the health of Adams County lake ecosystems and in classifying the water quality of the lakes.
- collect chemical and biological data on the named lakes to assist in assessing the health of Adams County lake ecosystems and in classifying the water quality of the lakes.
- develop a library of lake information that is centrally located and accessible to the public and to City, County, State and Federal agencies.
- make specific recommendations for actions and strategies for the protection, preservation and management of the lakes and their watersheds.
- create a baseline for future lake water quality monitoring.
- Provide technical information for the development of comprehensive lake management plans for each lake
- provide a basis for the water quality component of the Adams County Land and Water Resource Management Plan. Components of the plan will be incorporated into Adams County's "Smart Growth Plan".
- develop and implement educational programs and materials to inform and education lake area property owners and lake users in Adams County.

METHODS OF DATA COLLECTION

To collect the physical data, the following methods were used:

- delineation & mapping of ground & surface watersheds using topographic maps, ground truthing and computer modeling;
- identification of flow patterns for both the surface & ground watersheds using known flow maps and topographic maps;
- inventory & mapping of current land use with orthographic photos and collected county information;
- inventory & mapping of shoreline erosion and buffers using county parcel maps and visual observation;
- inventory & mapping for historical and cultural sites using information from the local historical society and the Wisconsin Historical Society;
- identification & mapping of critical habitat areas with WDNR and Adams County LWCD staff;
- identification & mapping of endangered or threatened natural resources (including natural communities, plant & animal species) using information from the Natural Heritage Inventory of Wisconsin;
- identification & mapping of wetland areas using WDNR and Natural Resource Conservation Service wetland maps;
- preparation of soil maps for each of the lake watersheds using soil survey data from the Natural Resource Conservation Service.

To collect water quality information, different methods were used:

- for three years, lakes were sampled during late winter, at spring and fall turnover, and several times during the summer for various parameters of water quality, including dissolved oxygen, relevant to fish survival and total phosphorus, related to aquatic plant and algae growth;
- random samples from wells in each lake watershed were taken in two years and tested for several factors;
- aquatic plant surveys were done on all 20 lakes and reports prepared, including identification of exotics, identifying existing aquatic plant community, evaluation of community measures, mapping of plant distribution, and recommendations;
- all lakes were evaluated for critical habitat areas, with reports and recommendations being made to the respective lakes and the WDNR;
- lake water quality modeling was done using data collected, as well as historical data where it was available.

WATER QUALITY COMPUTER MODELING

Wisconsin developed a computer modeling program called WiLMS (Wisconsin Lake Modeling Suite) to assist in determining the amount of phosphorus being loaded annually into a lake, as well as the probable source of that phosphorus. This suite has many models, including Lake Total Phosphorus Prediction, Lake Eutrophic Analysis Procedure, Expanded Trophic Response, Summary Trophic Response, Internal Load Estimator, Prediction & Uncertainty Analysis, and Water & Nutrient Outflow. The models that various types of data inputs: known water chemistry; surface area of lake; mean depth of lake; volume of lake; land use types & acreage. This information is then used in the various models to determine the hydrologic budget, estimated residence time, flushing rate, and other parameters.

Using the data collected over the course of the studies, various models were run under the WiLMS Suite. These water quality models are computer-based mathematical models that simulate lake water quality and watershed runoff conditions. They are meant to be a tool to assist in predicting changes in water quality when watershed management activities are simulated. For example, a model might estimate how much water quality improvement would occur if watershed sources of phosphorus inputs were reduced. However, it should be understood that these models predict only a <u>relative</u> response, not an exact response. Modeling results will be incorporated into topic discussions as appropriate.

DISSEMINATION OF PROJECT DELIVERABLES

The results of this study will be distributed various agencies, organizations and the public as previously described. Based on the classification information, the Adams County Land and Water Conservation Department will identify assistance requests and determine the appropriate future activities, based on the classification determinations. Goals, priorities and action items may include educational programs, further development of lake management plans and implementation of lake management plans.

ADAMS COUNTY INFORMATION

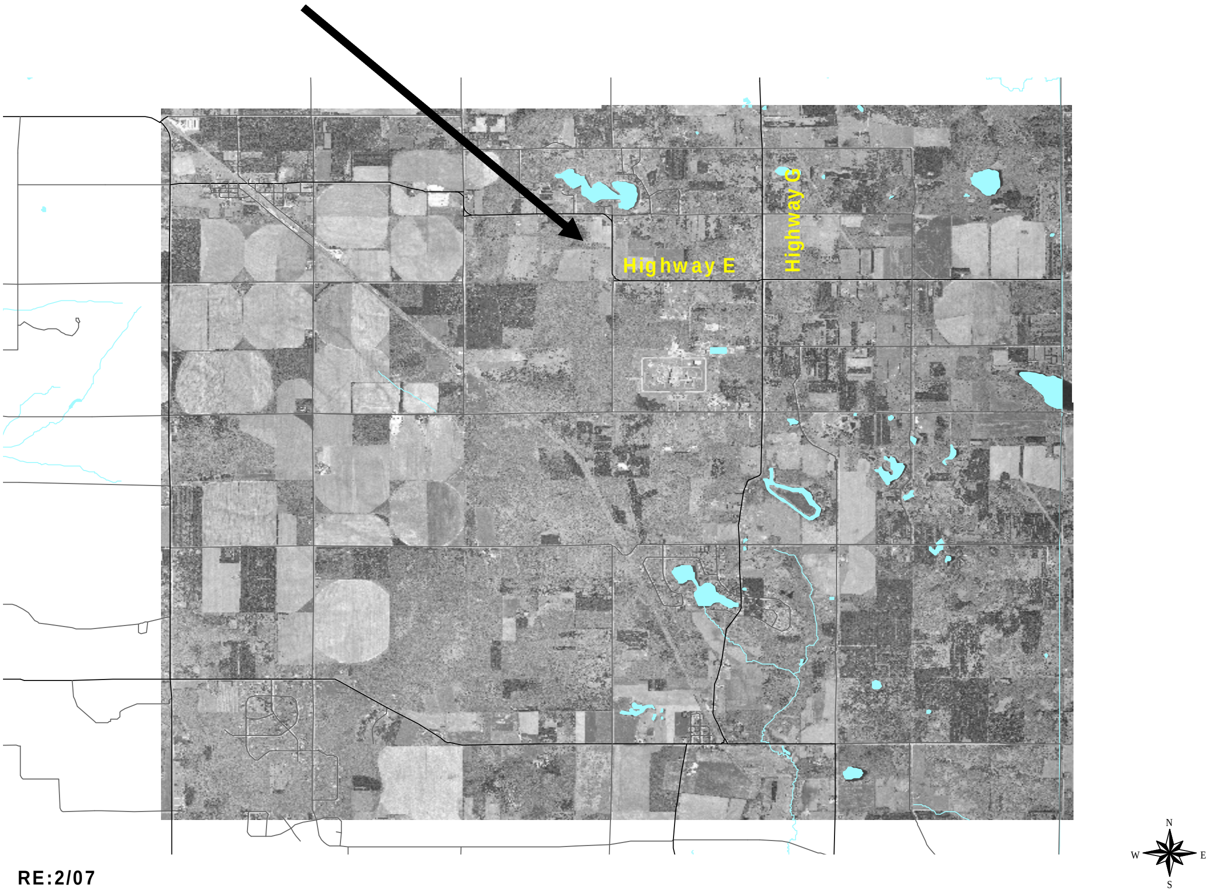
Adams County lies in south central Wisconsin, shaped roughly like the outline of Illinois. Adams County is a small rural county with a full-time population of about 20,000. Between 1980 and 2000, Adams County's population grew by more than 20%, with most of the population increase being located upon the lakes and streams. The population increase has resulted in a greater need for facilitation, technical assistance and education, including information on the lakes and streams.

Figure 1: Adams County Location in Wisconsin

PATRICK LAKE BACKGROUND INFORMATION

Patrick Lake is located in the Town of New Chester, Adams County, WI, in the south central part of Wisconsin. It is reached off of County E as it turns south. Patrick Lake is a mesotrophic seepage lake with good to very good water quality and clarity. It has 50 surface acres, with a maximum depth of 21 feet and a mean depth of 10 feet. In the past few years, the water level in Patrick Lake has been declining substantially. As in the case in all seepage lakes, the water level on Patrick Lake fluctuates naturally with the underground water table, but studies are underway to determine if some other factors may be contributing to the lowering water levels. There is a county park and boat launch at the southeast "corner" of the lake. The lake is management by the Patrick Lake District, formed in 1981, which has a proposed lake management plan pending before the WDNR at this time.

Figure 2: Patrick Lake location



The Central Sand Hills, which contain Patrick Lake, are found on the eastern edge of what once was Glacial Lake Wisconsin. The area is characterized by a series of glacial moraines that were later partially covered by glacial outwash. The area is a mixture of farmland, woodlots, wetlands, small kettle lakes and cold water stream, all on sandy soils. The combination of glacial moraines and pitted outwash has resulted in extensive wetlands in the outwash areas and the headwaters of cold water streams that originate in glacial moraines. Lakes in these areas tend to be fairly clean, but the groundwater tends to be vulnerable to contamination. Terrain tends to be undulating or rolling

Bedrock and Historical Vegetation

Bedrock in this area is mostly sandstone, both weak and resistant, formed in the Cambrian Period of Geology (542 to 488 millions years ago). Bedrock tends to be between 50 and 100 feet of the land surface, which is covered by lake, organic, till and glacial meltwater deposition.

Historic upland vegetation was oak-forest, oak savanna and tallgrass prairie. Current vegetation is about one-third agricultural crops and a number of grasslands with open wetland, open water, shrubs, barren and more urbanized areas. Woodland types are oak-hickory, with smaller areas of white-red-jack pine, maple basswood, lowland hardwoods and spruce-fir.

Soils in the Patrick Lake Watersheds

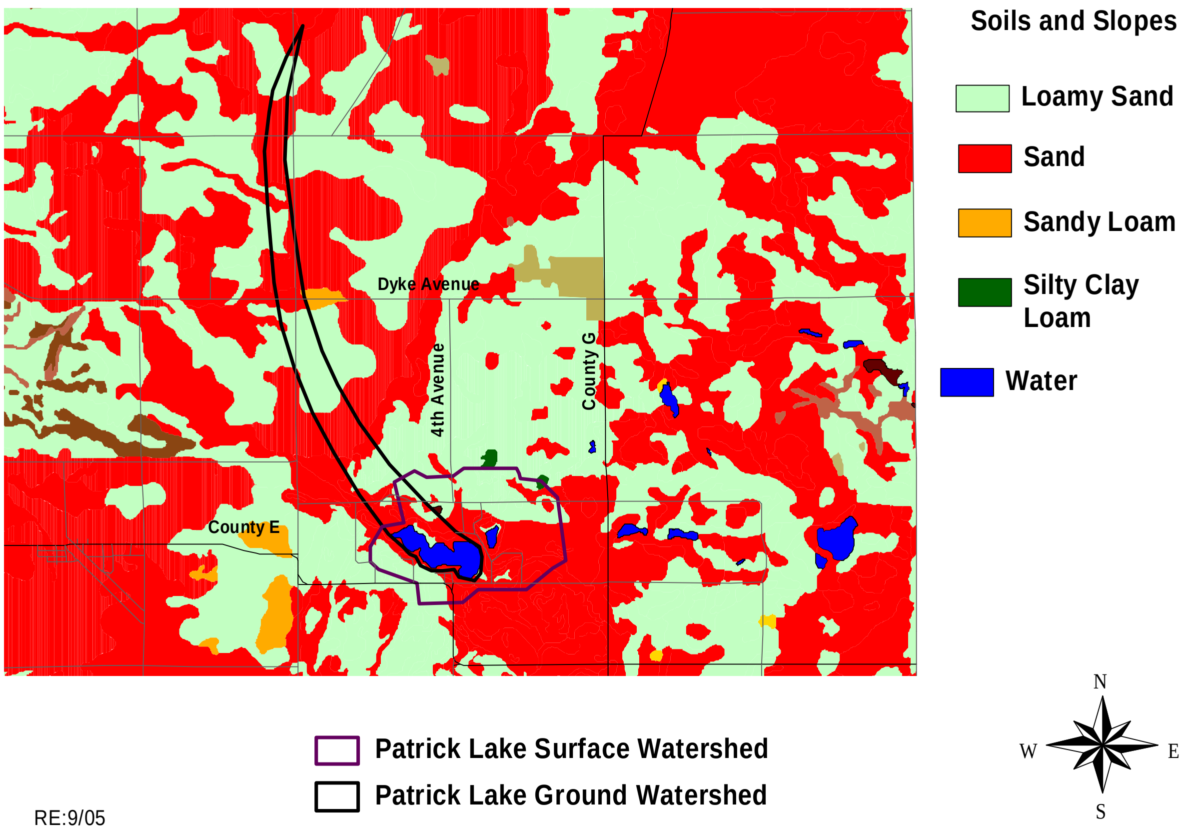
In both the surface and ground watersheds, the soils are fairly evenly divided between loamy sand and sand. There are small pockets of muck, sandy loam, and silty clay loam.

Loamy sands tend to be well-drained, with water, air and nutrients moving through them at a rapid rate. Runoff, when it occurs, tends to be slow. Loamy sands have little water-holding capacity and low natural fertility, although they usually have more organic matter present than do sandy soils. Both wind and water erosion are potential hazards with loamy sands, as is drought. There are difficulties with waste disposal and vegetation establishment because of slope and seepage.

Sandy soil tends to be excessively drained, no matter what the slope. Water, air and nutrients move through sandy soils at a rapid rate, so that little runoff occurs unless the soil becomes saturated. Although water erosion can be a problem, wind erosion may be more of a hazard with sandy soils, especially since these soils dry out so quickly. There are also draught hazards with sandy soils. Getting vegetation started in sandy soils is often difficult due to the low available water capacity, as well as low natural fertility and organic material. Onsite waste disposal in sandy soils is also a problem because of slope and seepage; mound systems are usually required.

The soil and soil slopes around lakes and streams are very important to water quality. They affect amount of infiltration of surface precipitation into the ground and the amount of contaminants that may reach the groundwater, as well as the amount of surface stormwater runoff. In addition, these two factors affect the amount and content of pollutants and particles (including soil) that may wash into a water body, affecting its water quality, its aquatic plant community and its fishery. Further, soil types and soil slopes help determine the appropriate private sewage system and other engineering practices for a particular site, since they affect absorption, filtration and infiltration of contamination from engineering practices.

Figure 3: Patrick Lake Watersheds Soils



PRIOR STUDIES OF PATRICK LAKE AREA

Lake Data Collection Survey of Patrick Lake in Adams County, WI

In 1983, a private-consulting organization, Northern Lake Service Inc., published a "lake data collection survey" report, summarizing work performed between November 1982 and October 1983. As part of this study, groundwater test wells were installed around Patrick Lake and tested monthly. It was found that Patrick Lake had a strong west to east gradient for groundwater, with the only inflow of groundwater into the lake occurring at the west end of the lake. At all other well sites, groundwater flowed away from the lake. All the test sites had elevated phosphorus and several also had elevated nitrogen.

Surface water was also tested monthly during the growing season and in the spring and fall. Growing season chlorophyll-a levels ranged from 095 2.95 micrograms/liter, all of which are low. Total phosphorus growing season levels ranged from 10.5 to 26 micrograms/liter. Water clarity stayed high, with Secchi disk readings ranging from 8.9 feet to 19.7 feet. Dissolved oxygen levels remained sufficient for fish survival, even in the winter. Hardness was 102.4 milligrams/liter of $CaCO_2$; alkalinity was 92.3 milliequivalents/liter.

Sediment probes showed a lot of nutrient-rich organic materials that were estimated at nearly 1,000,000 cubic yards, filling in nearly 2/3 of the lake's original volume. A grid was set up over the lake and water and depth to hard bottom measurements taken in 1982. Deepest water was found in the middle lobe of the lake at 25 feet. The west and east lobes had a maximum depth of 10 feet. However, depth to hard bottom (through the sediment) was 35 feet in the west lobe, 45 feet in the middle lobe and 40 feet in the east lobe.

An aquatic plant survey was done in 1983 as part of this study. Reports indicated that dense aquatic plant growth was common in Patrick Lake, and the 1983 survey found dense macrophytic growth, in keeping with the historical reports. The most abundant submergent plant in 1983 was *Potamogeton praelongus* (flat-stemmed pondweed). The second most abundant plan in the two western basins was the floating-leaf plant, *Nymphaea odorata* (white water lily). The second most abundant plant in the eastern basin was also a floating-leaf plant, *Brassenia schreberi* (common watershield). Overall, 14 aquatic species were found in the lake in 1983, including 2 emergent plants, 4 floating-leaf plants, and 8 submergent plants. The report noted that emergent were especially scarce. Filamentous algae was found and reached nuisance proportions by August 1983.

The report concluded that all of Patrick Lake served as a littoral zone, with productivity, nutrient utilization and autochthonous sedimentation occurring at an accelerated rate. It noted that the size and shape of the lake, as well as the large amounts of sediments, were not suited for speed boats or water-skiing, both of which were likely to disturb lake sediments and fragment aquatic plants. The report indicated that the best method to turn back eutrophication, heavy weed growth, increased sedimentation and winterkill would be massive dredging, but it opined that the cost of such a project was likely to be outside the Lake District's taxing power. The report recommended dealing with eutrophication symptoms by aeration and chemical/mechanical aquatic plant control.

A Trophic State Index calculation was performed that result in an overall TSI for Patrick Lake of 44, which fell into the "mesotrophic" range for lakes.

Feasibility Study Results & Management Alternatives

The document, published in 1985 by the WDNR's Bureau of Water Resources Management, used the data gathered by the Northern Lake Service in the earlier study, as well as its own data, to make findings and recommendations regarding management of Patrick Lake. The objective of this study were: develop a water budget for Patrick Lake; develop a nutrient budget; characterize in-lake chemistries and biological processes for an index of lake "health", and to develop a set of lake management alternatives that would protect and improve the present water quality.

As part of this study, the land use in the surface watershed of Patrick Lake was evaluated. At that time, only 5% of the land was in agricultural use, with 48% woodlands, 11% low density residential, and 36% water making up the balance. The mean depth of the lake at that time was 7.9 feet. Estimates of sources of inflow to the lake water were: precipitation, 51.9%; runoff, 31.8%; and groundwater, 11.7%. Outflow from the lake was 50.7% to the groundwater and 49.3% into evaporation.

Authors of this report did estimate phosphorus loading from various sources. It indicated that 5.6 pounds/year of phosphors (23%) came from woodlands; 4.7 pounds/year (19%) came from agriculture; 3.9 pounds/year (17%) came from low density residential land use; and 9.9 pounds/year (41%) came from atmospheric deposition. Additional evaluation suggested that there was also a moderate risk of phosphorus deposition from aging septic systems.

This report concluded that most of the lake sediment accumulation was due to natural in-lake biological processes. Even without any further phosphorus or sediment input, the lake bottom was determined to be nutrient-rich enough to support abundant aquatic plant growth for many years. At that time, most of the primary productivity of the lake went into aquatic plants, rather than into free-floating algae. Although the high density of plants was likely limiting the growth rate of planktonic algae, the report noted that filamentous algae reached nuisance levels by late summer.

A number of recommendations and considerations were outlined for management of Patrick Lake:

- The district should concentrate on lake protection and activities aimed at minimizing nutrient loading & sedimentation to lake from surface runoff, soil loss and groundwater.
- Due to the high fertility of the sediments, the district should look at alternatives for management, using watershed practices, weed harvesting, bottom screens and dredging to deepen the lake to reduce the sediment amount and fertility.
- Watershed practices recommended included:
    1. Install a strip of land parallel to the shore, all around the shore, at a minimum width of 20 feet landward, that was vegetated by native plants;
    2. Have landowners rake leaves & other yard waste far back from the shore to keep decomposing plant materials from adding to the lake nutrient load;
    3. Have landowners construct berms to encourage runoff ponding and infiltration of stormwater runoff before it can reach the lake;
    4. Have landowners direct runoff to areas where seepage can occur;
    5. Minimize the amount of impervious areas around the lake;
    6. Control construction site erosion;
    7. Discourage the use of lawn fertilizers and chemicals, especially those with phosphorus. Ask landowners to do a soil sample first to determine what, if any, nutrients are needed before any fertilizer is added.
    8. Since the soils around the lake have severe limitations for septic tank absorption fields that make groundwater contamination likely, reduce septic loading from all around the lake, either on a voluntary basis or as a Sanitary District;
    9. Implement a water quality monitoring program measuring at least water clarity, total phosphorus and dissolved oxygen. Have citizens participate in the WDNR self-help training and monitoring.
    10. Control recreational activities that cause wave action and pollution from increased boat traffic.

- Aquatic Plant Harvesting recommendations included:
    1. Harvest aquatic plants, but leave the emergent and floating-leaf plants for habitat;

2. Harvest recreational areas used for navigation, swimming, etc.;
3. Consider sharing the use of a larger, more efficient mechanical harvesting with another lake(s);
4. Consider using selective harvesting to address certain areas;
5. Don't use chemicals to treat aquatic plants unless all other measures are shown to be ineffective, because the use of chemicals would cause plant decomposition to add to the already-high nutrient bed;

- Use of Bottom Screens considerations included:
  1. If screens are placed on the bottom to discourage plant growth and stabilize the sediments, be sure to remove and clean them annually;
  2. Such screens could be used to break up dense plant stands;
  3. Such screens require WDNR permit.

- Dredging considerations included:
  1. Removal of all the soft sediments in the lake would cost over $2 million, and it might be difficult to find suitable disposal sites for the removed soils. 240 acres would be needed just to spread 1 foot thick layer of sediments;
  2. Deepening of only the eastern half or other partial removals are not recommended because they wouldn't solve the problem of much of the lake having such fertile sediments;
  3. Soft sediments such as those in Patrick Lake might shift and refill any partially dredged areas fairly quickly.
  4. Dredging might have at least a temporary negative impact on the lake fishery.

<u>Patrick Lake Management Plan: A Study of Present Watershed Conditions & an Investigation of Baseline Water Quality & Biological Conditions</u>

This study was conducted by a private consulting firm, Mid-State Associates Inc, in 1993-1994 and published in 1995. It noted that Patrick Lake had a history of clear water and was generally less fertile & productive than most of the lakes in the area, with many reports of dense aquatic plant growth, but few of nuisance algal blooms. Due to its depth at the time, the lake went through an annual cycle of stratification and mixing. Overall, the water quality was determined to be good, with low to moderate levels of both nitrogen and phosphorus.

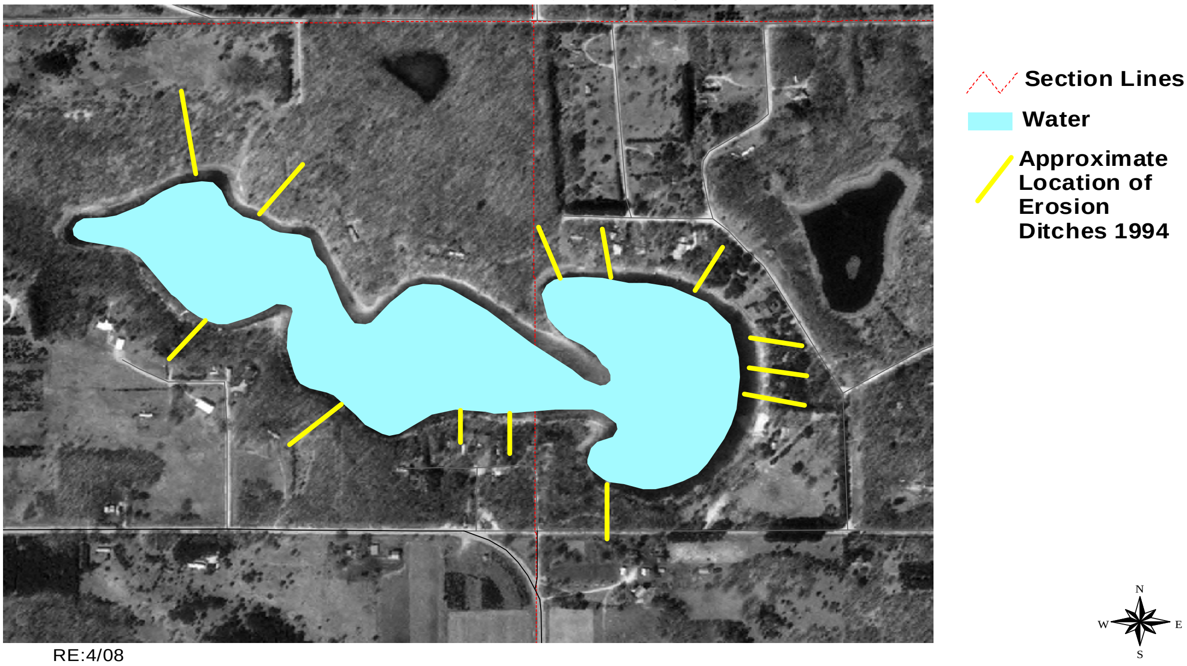
As part of this study, growing season water quality samples were taken. Secchi disk readings were in the 14 to 16 foot range. Total phosphorus levels ranged from a low of 12 to a high of 21 micrograms/liter. Chlorophyll-a levels were also generally low, ranging from 2.45 to 6.83 micrograms/liter. An updated Trophic State Index calculation rated Patrick Lake's overall TSI at 38, falling into the "oligotrophic" level.

An abbreviated aquatic plant survey was also conducted, finding nine species, including 3 floating-leaf plant species, 2 emergent plant species, and 4 submergent species, including one exotic invasive, *Potamogeton crispus* (curly-leaf pondweed).

The authors of this report reviewed the stocking and survey records for fish in Patrick Lake. The fishing was panfish-dominated, with very high populations of bluegill and pumpkinseed, often stunted.

A shoreline erosion survey identified 12 small "ditches" of erosion into the lake. It was estimated that erosion from these ditches had contributed 25 to 50 tons of sediment to the lake.

Figure 4: Erosion "Ditches" around Patrick Lake 1993-1994



As part of this study, a survey of the landowners in the district was conducted. The survey revealed that the three most common uses of the lake were fishing, scenery and swimming. People had chosen Patrick Lake for its distance from their home, the cost of property there, and the low number of public users. Highest use of the lake properties were in the summer and weekends, with very few permanent residents.

Both water clarity and water quality were seen as good. Over 66% of the respondents called the aquatic plant growth “heavy” or “dense”. The main issues for the Lake District to oversee, according to the respondents, were the algae/aquatic plant growth; fish stocking; and a long-term management plan.

This report also made a number of recommendations:

- Minimize any additional sediment or phosphorus input into the lake.
- Collect litter to keep it from ending up in the lake.
- Leave uncut buffers along the lake shores and roadsides.
- Use best management practices even in flower & vegetable gardens, including leaving residue, modified conservation tillage, integrated pest management and use of few chemicals.
- Inspect lake area septic systems to ensure proper functioning.
- Track land use in the watershed at least every 5 years, including changes in development and agricultural use.
- Regularly monitor the water during the spring and fall turnovers for total phosphorus, ammonium, nitrate-nitrite, TK-nitrogen, total hardness, and total alkalinity.
- During the growing season, monitor the water quality for Secchi disk readings, temperature, dissolved oxygen, and pH.
- If dredging is to be done to remove sediment, it has to deepen the lake to more than 20 feet deep or it won’t be deep enough to keep water during groundwater fluctuations.
- Small scale dredging is unlikely to be effective.
- No use of chemicals to control aquatic plant growth is recommended unless nothing else has proved successful, because such treatment increases the nutrient load, is expensive due to the need for repeated applications, and may negatively affect non-target species.
- Harvest navigational channels in vegetative beds, including branching channels for navigation to docks, etc.
- Regularly monitor any treatment or harvest to evaluate success.
- Encourage catch/release for bass and northern pike, plus remove small fish such as bluegills and pumpkinseed, to bring panfish population into balance.
- Perform long-term fishing monitoring every 2 to 6 years.
- Measure water depth every quarter to correlate water table elevations and precipitation.
- Limit boating hours, establish no-wake zones on the lake and limit the motor size or type.

CURRENT LAND USE

Studies have shown that lakes are products of their watersheds, with land use having a great impact on the water quality of that lake, especially in the amount and content of stormwater runoff from the surface. Stormwater runoff volume is affected by the amount of impervious surface, the soil type and the slope of the area. Stormwater runoff from natural landscapes tends to be low. While the surface watershed of Patrick Lake is fairly small, the ground watershed goes east and north of the lake about three miles. Woodlands are the largest land use category in both Patrick Lake watersheds. Since forest floors are often full of leaves, needles and other duff, runoff from forested lands is may be more filtered than that from agricultural or residential lands. Residential land use is the second most common land use category in both the Patrick Lake watersheds, especially around the lake itself, where residential land use is most concentrated. This land use category may contribute a significant amount of nutrients to the water from stormwater runoff, mowed lawns, and impervious surfaces. Septic systems may also add to nutrient loading from residential land use. Agricultural land use may contribute significantly to the amount of nutrient loading in a watershed. While only a small part of the surface watershed of Patrick Lake is in agricultural use, the ground watershed has a much larger portion of its land use in agriculture.

Figure 5: Patrick Lake Watersheds Land Use in Acres and Percent of Total

	Surface		Ground		Total	
Patrick Lake	**Acres**	**% Total**	**Acres**	**% Total**	**Acres**	**% Total**
Agriculture--Non Irrigated	87.8	8.51%	63.71	12.09%	151.51	9.72%
Agriculture--Irrigated	0	0.00%	239.22	45.41%	239.22	15.34%
Residential	437.16	42.35%	23.18	4.40%	460.34	29.53%
Water	50.1	4.85%	5.26	1.00%	55.36	3.55%
Woodland	457.2	44.29%	195.43	37.10%	652.63	41.86%
total	1032.26	100.00%	526.8	100.00%	1559.06	100.00%

Studies have shown that land use around a lake has a great impact on the water quality of that lake, especially in the amount and content of surface runoff. (James, T., 1992, I-10; Kibler, D.F., ed. 1982. 271) For example, while natural woodland may (on the average) absorb 3.5” out of a 4” rainfall, leaving only .5” as runoff, a residential area with quarter-acre lots may absorb only 2.3” of the 4”, leaving 1.7” to run off the land into the lake—the same amount as may be expected to run off from a corn or soybean field. 1.7” of runoff translates into 46,200 gallons per acre ending up in the lake! Percentage of impervious surface, the soil type, vegetation present and slope of the site can all affect runoff volume. (Frankenberger, J, ID-230). The changes in the Patrick Lake watersheds land uses are therefore likely to significantly increase the runoff in volume and content unless protection steps are taken.

Figure 6a: Land Use in Patrick Lake Surface Watershed

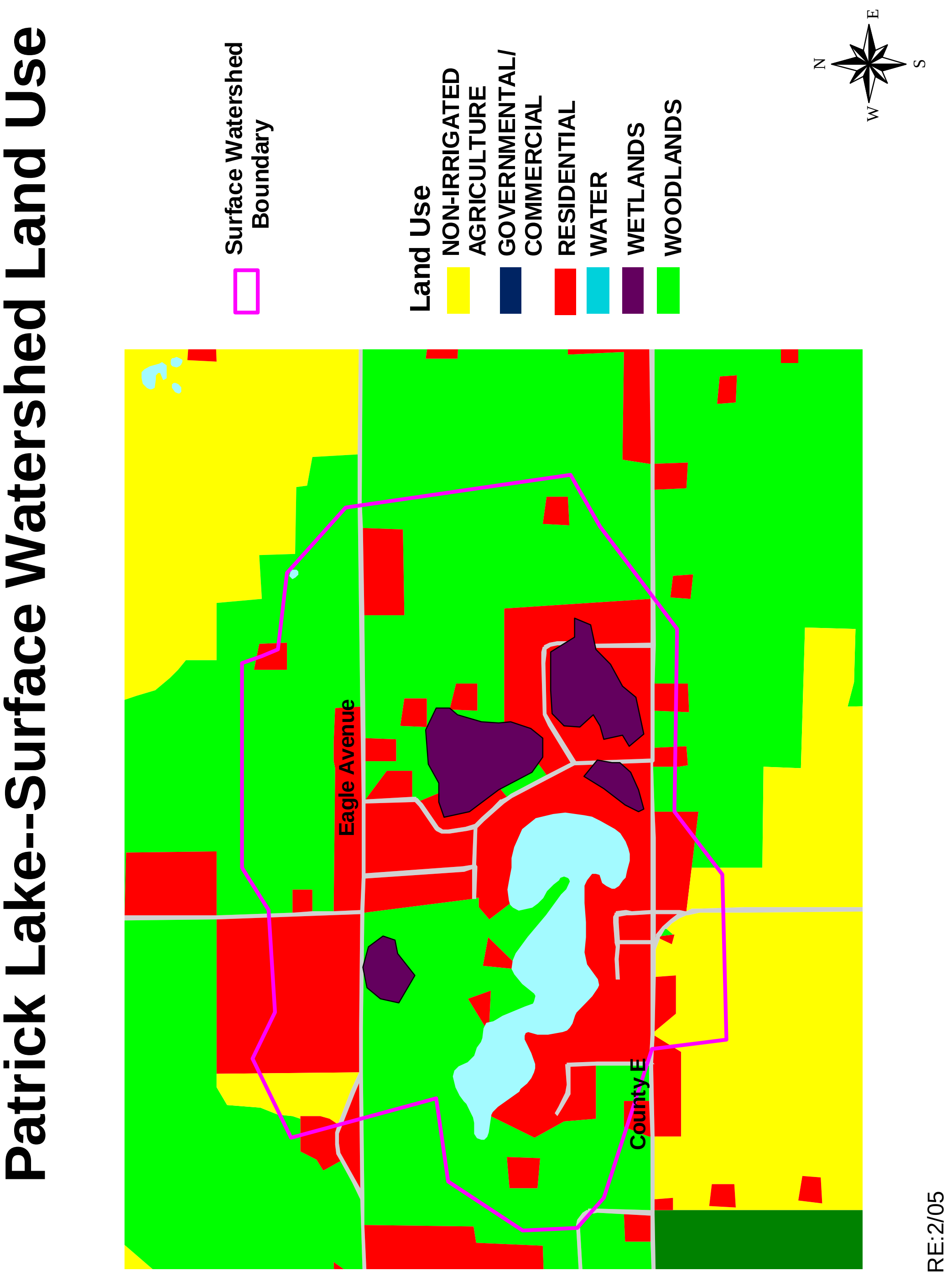
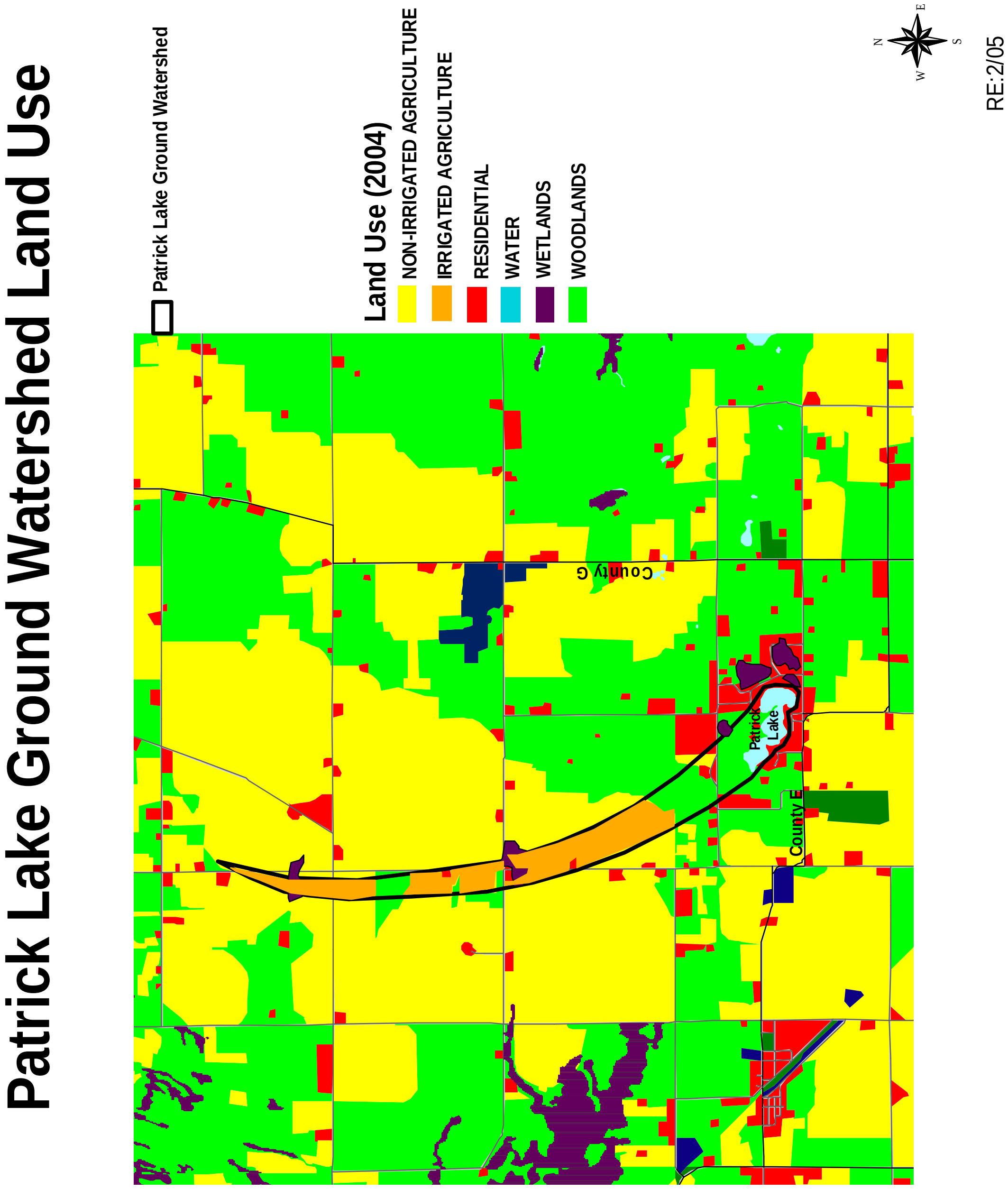
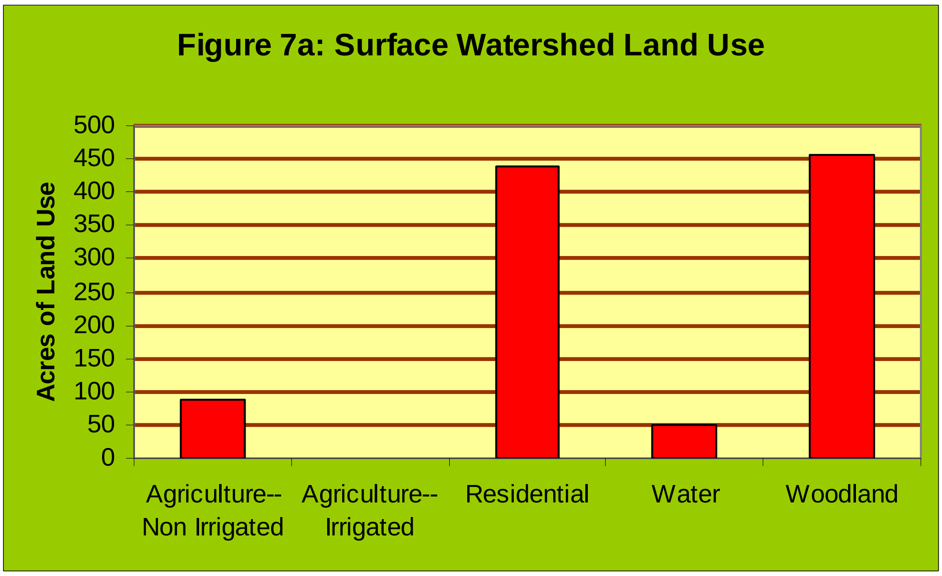
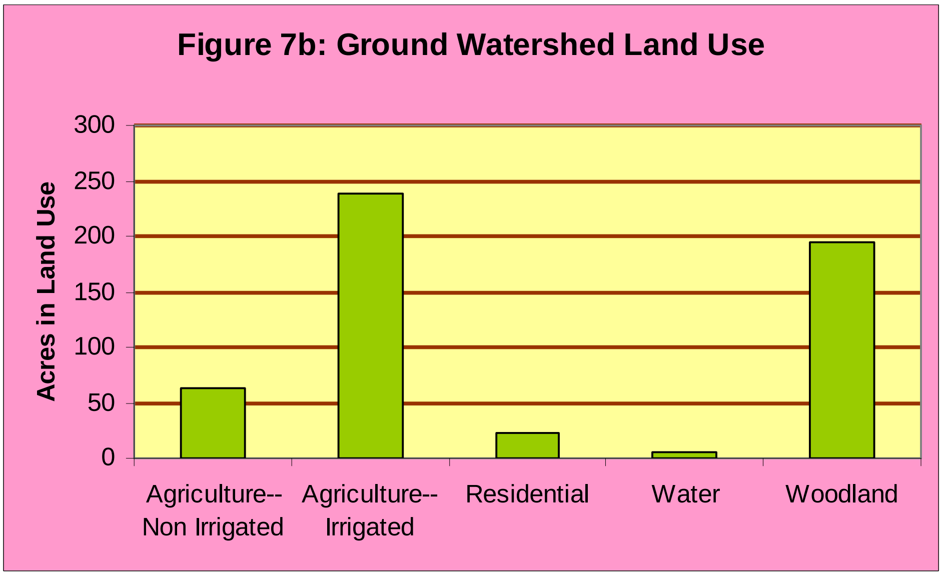


Figure 6b: Land use in Patrick Lake Ground Watershed



When water runs over a surface, it picks up whatever loose pollutants—sediment, chemicals, metals, exhaust gas, etc—are present on that surface and takes those items with it into the lake. Increased development around a lake tends to increase the amount of pollutants being carried into the lake, thus negatively affecting water quality. Residential development areas with lots of one-quarter acre or less may deliver as much as 2.5 pounds of phosphorus per year to the lake for each acre of development.





There is one specific kind of land use type—shoreland--that is so important to water quality it will be separately discussed.

SHORELANDS

Patrick Lake has a total shoreline of 1.68 miles (8870.4 feet). Much of the shore in the northwest lobe and in the west part of the center lobe of the lake has been left mostly undisturbed. Buildings in these areas tend to be uphill and more than 70' from the shore. The eastern lobe of the lake is in residential use and park use. Most of the areas in this lobe are flatter than the northwest end. Buildings in this lobe are generally located closer to the shoreline than those on the west part of the lake. 80% of Patrick Lake's shoreline is vegetated.

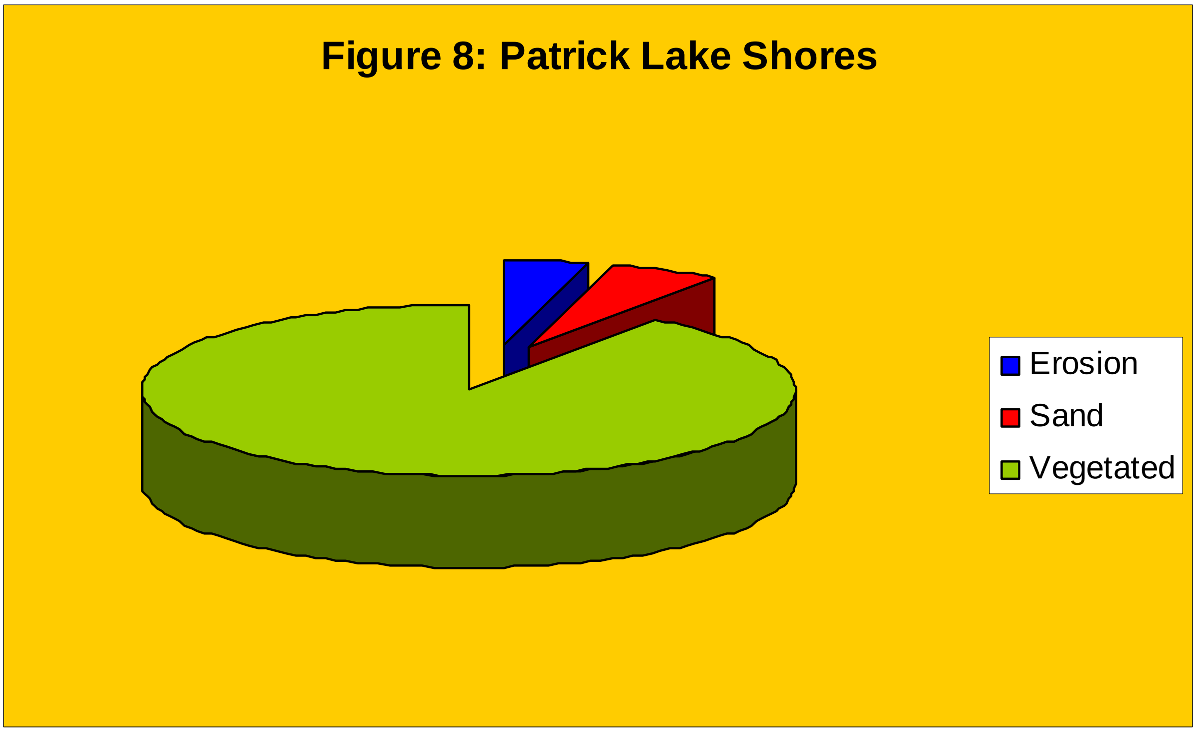
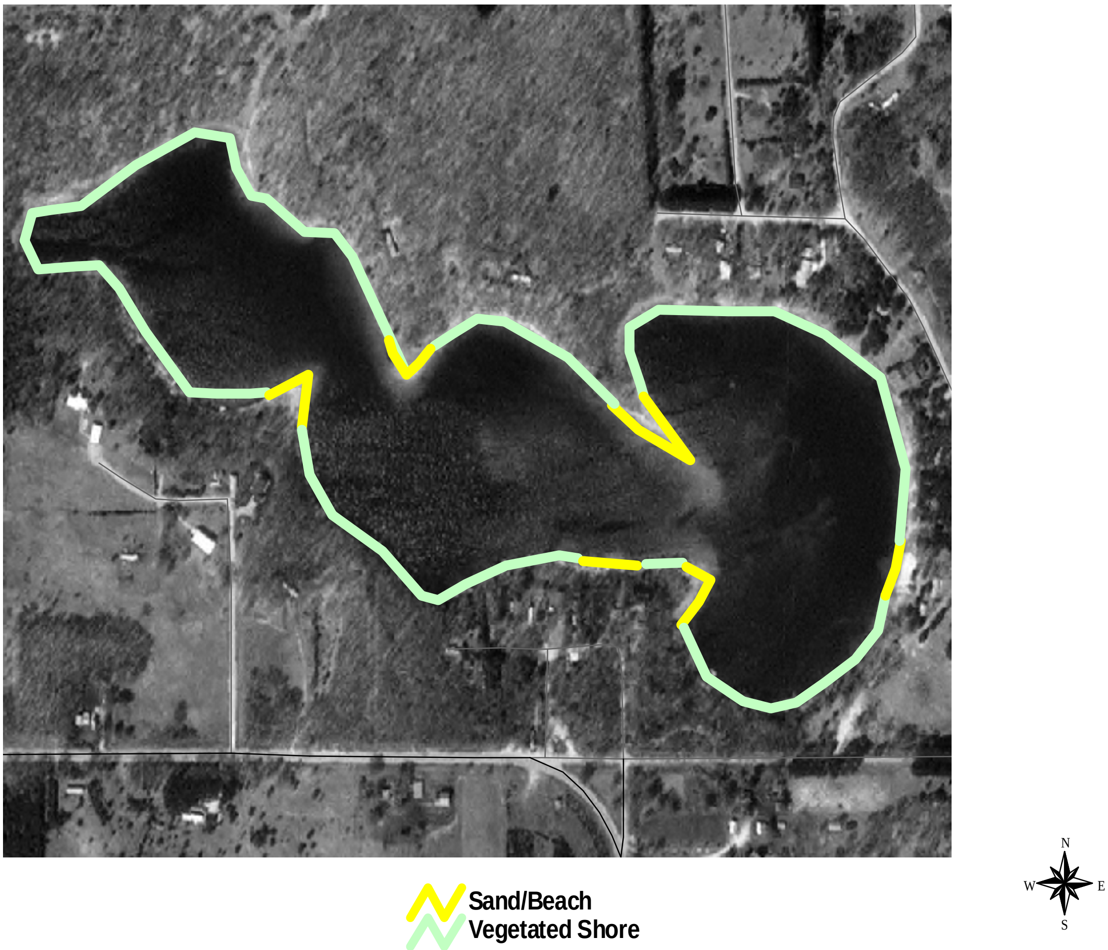


Figure 9: Shoreland Map of Patrick Lake (2004)



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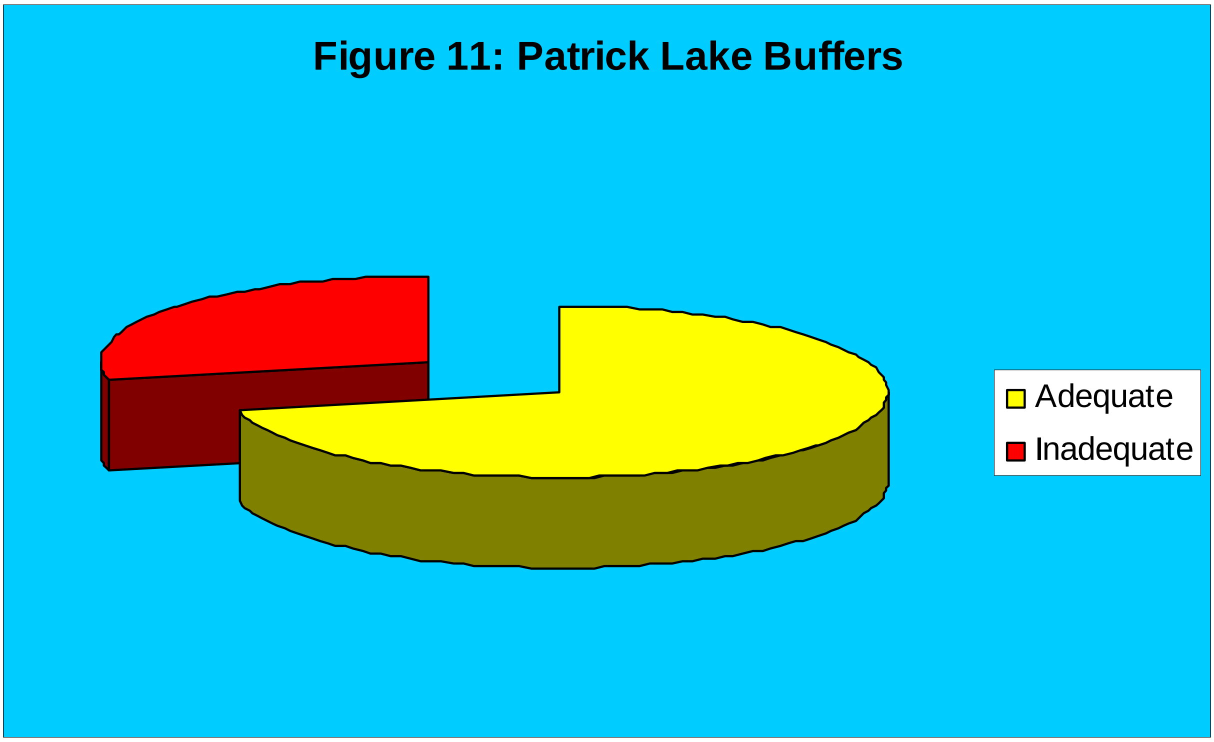
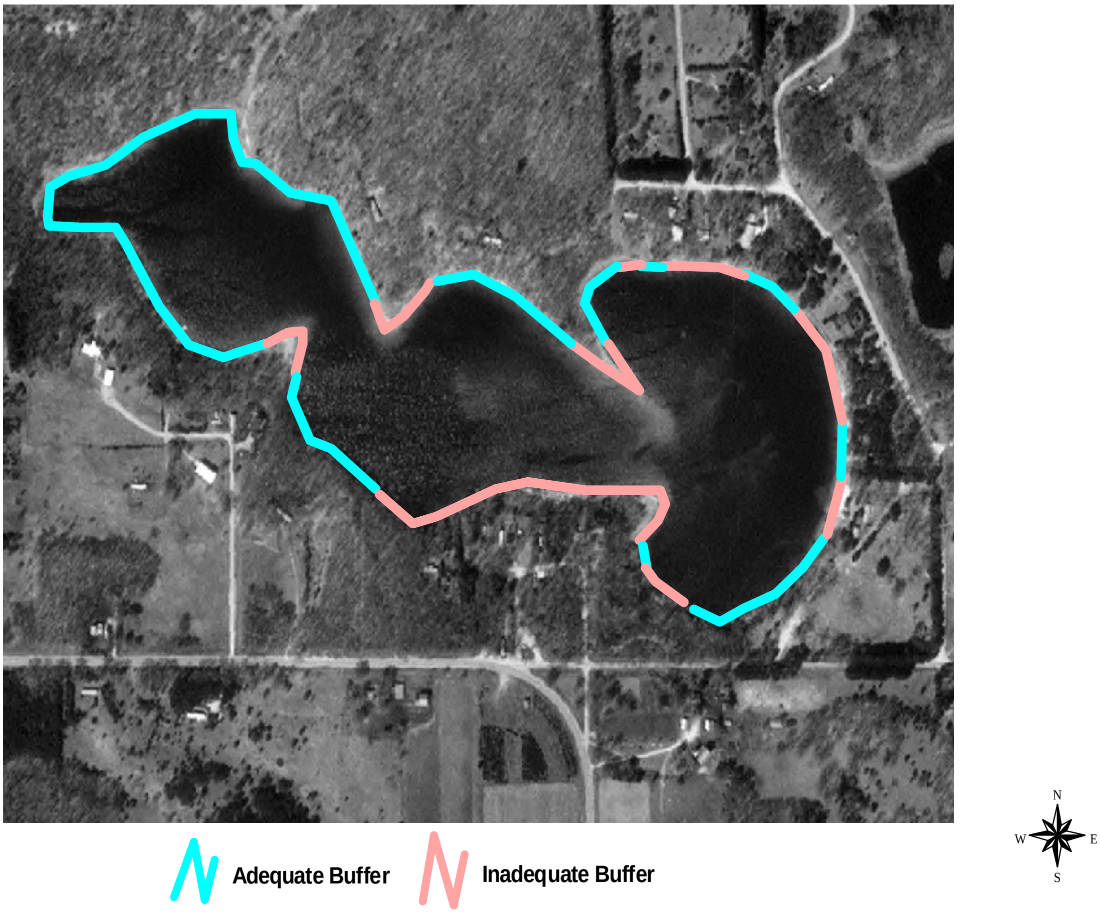
The Adams County Shoreline Ordinance defines 1000 feet landward from the ordinary high water mark as "shoreland". Under the ordinance, the first 35 feet landward from the water is a "buffer." Shoreland buffers are an important part of lake protection and restoration. These buffers are simply a wide border of native plants, grasses, shrubs and trees that filter and trap soil & similar sediments, fertilizer, grass clippings, stormwater runoff and other potential pollutants, keeping them out of the lake. A 1990 study of Wisconsin shorelines revealed that a buffer of native vegetation traps 5 to 18 times more volume of potential pollutants than does a developed, traditional lawn or hard-armored shore.

A 2004 shore survey showed that most of the shore had an "adequate buffer." An "adequate buffer" is a native vegetation strip at least 35 feet landward from the shore. However, there were still areas of "inadequate" buffers, mostly those with mowed lawns and insufficient native vegetation at the shoreline to cover 35 feet landward from the water line. There are also several areas of sand bars and some active erosion.



Vegetated shoreland buffers help stabilize shoreline banks, thus reducing bank erosion. The plant roots give structure to the bank and also increase water infiltration and decrease runoff. A vegetated shore is especially important when shores are steep and soft, as are some of Patrick Lake shores. Figure 12 maps the adequate and inadequate buffers on Patrick Lake.

Figure 12: Patrick Lake Buffer Map (2004)



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Lakeside buffers also serve as important habitat. Lake edges usually contain aquatic and wetland plants, grading into drier groundcover, then shrubs and trees as one moves inland towards drier land. Buffers provide habitat for many species of water-dependent wildlife, including furbearers, reptiles, birds and insects. Many wildlife species, including birds, small mammals, fish & turtles breed, nest, forage and/or perch in shore buffer areas. Further, 80% of the endangered and threatened species listed spend part of their life in this near-lake buffer area. (Wagner et al, 2006)

When the natural shoreline is replaced by traditional mowed turf-grass lawns, rock, wooden walls or similar installments, bird and animal life, land-based insects, and aquatic insects that hatch or winter on natural shore are negatively impacted. For example, on many Adams County lakes, the non-native aquatic plant, Eurasian Watermilfoil has invaded. There is a weevil native to Wisconsin that weakens Eurasian Watermilfoil by burrowing into and developing within its stems, but that weevil depends on a native-plant shore to overwinter. If the shore is instead covered by rock, seawall or traditional lawn, these weevils will be unavailable for the lake to use as Eurasian Watermilfoil control.

The filtering process and bank stabilization that buffers provide help improve a lake's water quality, including water clarity. Studies in Minnesota, Maine and Michigan have shown that waterfront property value increases for every foot the water clarity of a lake increases. (Krysel et al, 2003).

Figure 13: Example of Inadequate Vegetative Buffer

Figure 14: Example of Adequate Buffer

Natural shoreland buffers serve important cultural functions. They enhance the lake's aesthetics. Studies have shown that aesthetics rank high as one of the reasons people visit or live on lakes. Shore buffers can provide visual & audio privacy screens for homeowners from other neighbors and/or lake users.

Adequate buffers on Patrick Lake in some places could be easily installed on the inadequate areas by either letting the first 35 feet landward from the water just grow without mowing it, except for a path to the water, or by planting native seedlings sufficient to fill in the first 35 feet or using biologs to protect the shore that are vegetated. Where areas are deeply eroded, shaping, revegetating and protecting the shores will be necessary to prevent further erosion.

Figure 15: Vegetated Buffer on Patrick Lake

WATER QUALITY

Between 2004 and 2006, Adams County Land & Water Conservation Department gathered water chemistry and other water quality information Patrick Lake. Part of the information was gained from periodic water sampling done by Adams County LWCD. Historic information about water testing on Patrick Lake was also obtained from the WDNR in a series of tests in 1986-1987, 1993, 1996-1997, and from Self-Help Monitoring records of 2002.

Phosphorus

Patrick Lake is a phosphorus-limited lake: of the pollutants that end up in the lake, the one that most affects the overall quality of the lake water is phosphorus. The amount of phosphorus especially affects the frequency and density of aquatic vegetation and the frequency and density of various kinds of algae, as well as water clarity and other quality aspects. One pound of phosphorus can produce as much as 500 pounds of algae.

Phosphorus is not an element that occurs in high concentration naturally, so any lake that has significant phosphorus readings must have gotten that phosphorus from outside the lake or from internal loading. Some phosphorus is deposited onto the lake from atmospheric deposition, especially from soil or other particles in the air carrying phosphorus. A lake that includes a flooded wetland area may have a significant amount of phosphorus being released during the flushing of the wetland area. Phosphorus may accumulate in sediments from dying animals, dying aquatic plants and dying algae. If the bottom of the lake becomes anoxic (oxygen-depleted), chemical reactions may cause phosphorus to be released to the water column.

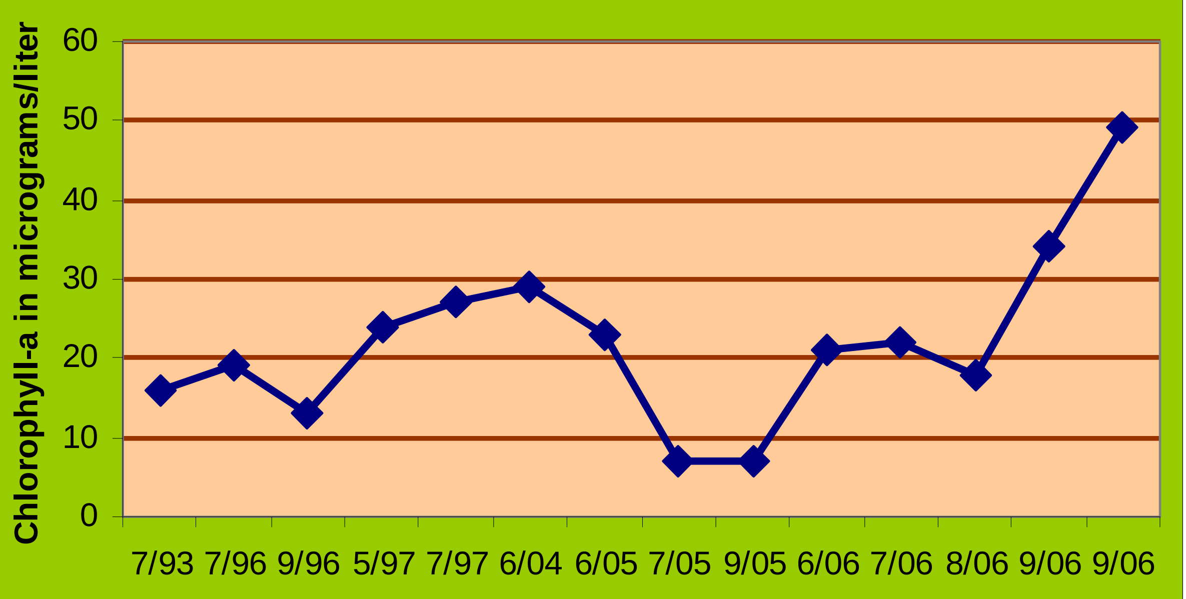
Although there are several forms of phosphorus in water, the total phosphorus (TP) concentration is considered a good indicator of a lake's nutrient status, since the TP concentration tends to be more stable than other types of phosphorus concentration. For an impoundment lake like Patrick Lake, a total phosphorus concentration below 30 micrograms/liter tends to prevent nuisance algal blooms. Patrick Lake's growing season (June-September) surface average total phosphorus level of 17.3 micrograms/liter is considerably under the level at which nuisance algal blooms can be expected in the lake overall. However, areas of Patrick Lake do have nuisance-level algal blooms.

Since phosphorus is usually the limited factor, measuring the phosphorus in a lake system thus provides an indication of the nutrient level in a lake. Increased phosphorus in a lake will feed algal blooms and also may cause excess plant growth.

The 2004-2006 summer average phosphorus concentration in Patrick Lake places the lake in the "good" water quality section for impoundments, and in the "mesotrophic" level for phosphorus. The total epilimnetic phosphorus levels have been varied in Patrick Lake, but there does seem to be an upward trend overall. In 1993, the earliest information available, eplimnetic total phosphorus was 16 micrograms/liter in July. By July of 1997, the eplimnetic total phosphorus was 27 micrograms/liter. By July 2006, it was 22 micrograms/liter, slightly less than 1997, but above 1993. These levels suggest that nutrients may be accumulating in the lake as time goes on.

However, the growing season total phosphorus levels have still generally registered below the level recommended to avoid nuisance algal blooms. The eplimnetic total phosphorus levels from 1993 to 2005 stayed below the natural lake recommendation of 30 micrograms/liter. There was a spike above that level in late summer 2006, but that year was unusually hot and dry, which may have elevated the levels temporarily. With such variation, phosphorus should continue to be monitored and steps should be taken to reduce the phosphorus levels in the lake.

Figure 16: Eplimnetic Phosphorus Levels



Groundwater testing of various wells around Patrick Lake was done by Adams County LWCD and included a test one year for total phosphorus levels in the groundwater coming into the lake. The average TP level in the wells tested an average of 15.67 micrograms/liter, very close to the lake surface water results. With those levels, groundwater contribution of phosphorus to the lake may be limited.

Land use plays a major role in phosphorus loading. A key component of the computer models used is the phosphorus budget, that is, the estimated amount of phosphorus delivered to the lake from each land use type annually. Using the current land use data, as well as phosphorus readings from 2004 through 2006 water sampling, a phosphorus loading prediction model was run for Patrick Lake. The current results are shown in Figure 17.

Figure 17: Current Phosphorus Loading by Land Use

MOST LIKELY PHOSPHORUS LOADING		
BY LAND USE	**% Loading**	**current**
Non-Irrigated Agriculture	28.0%	30.80
Residential	17.5%	19.80
Woodlands	18.3%	19.80
Ground Watershed	21.1%	24.20
Lake Surface	6.0%	6.60
Septics	9.1%	10.38
total in pounds/acre	100.0%	111.58

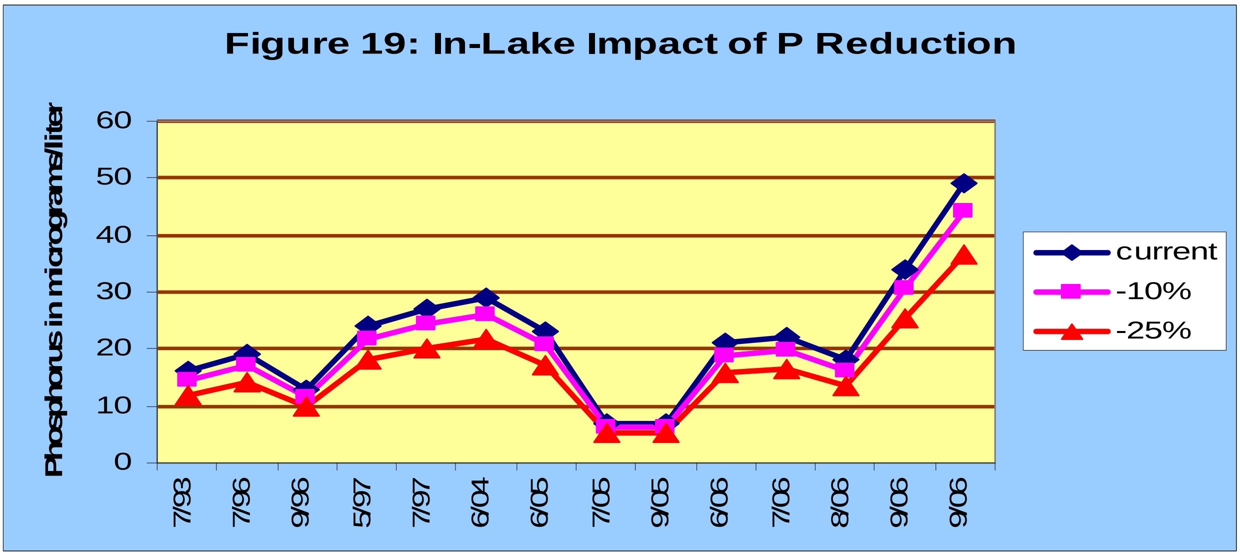
Currently, the most phosphorus loading in the surface watershed is coming from non-irrigated agriculture and from the ground watershed. Although phosphorus deposits such as that from flooded wetlands or from atmospheric deposition cannot be controlled by humans, phosphorus loads from human activities such as agriculture, residential development and septic systems can be partly controlled by changes in human land use patterns. Practices such as agricultural buffers, nutrient management, shoreland buffer restoration; infiltrating stormwater runoff from roof tops, driveways and other impervious surfaces; using no phosphorus lawn fertilizers; and reducing phosphorus input to and properly managing septic systems will minimize phosphorus inputs into the lake. Circumstances such as increased impervious surface, lawns mowed to water's edge, disturbance of shore areas, improperly-functioning septic systems and removal of native vegetation can greatly increase the volume and content of runoff—and thus increase the volume of phosphorus entering the lake. Many of these practices can also increase the concentration of phosphorus entering the lake, by runoff or other methods of entry.

The models were run using not only the current known phosphorus readings in the lake, but also representing decreases or increases of human-controlled phosphorus input by 10%, 25%, and 50%. Just a 10% reduction of the human-impacted phosphorus would reduce the overall load by 6.64 pounds/acre/year. This figure may not seem like much---until you calculate that one pound of phosphorus can result in up to 500 pounds of algae. A 10% reduction in these three areas could result in up to 4255 pounds less of algae per year!

Figure 18: Impact of Phosphorus Reduction

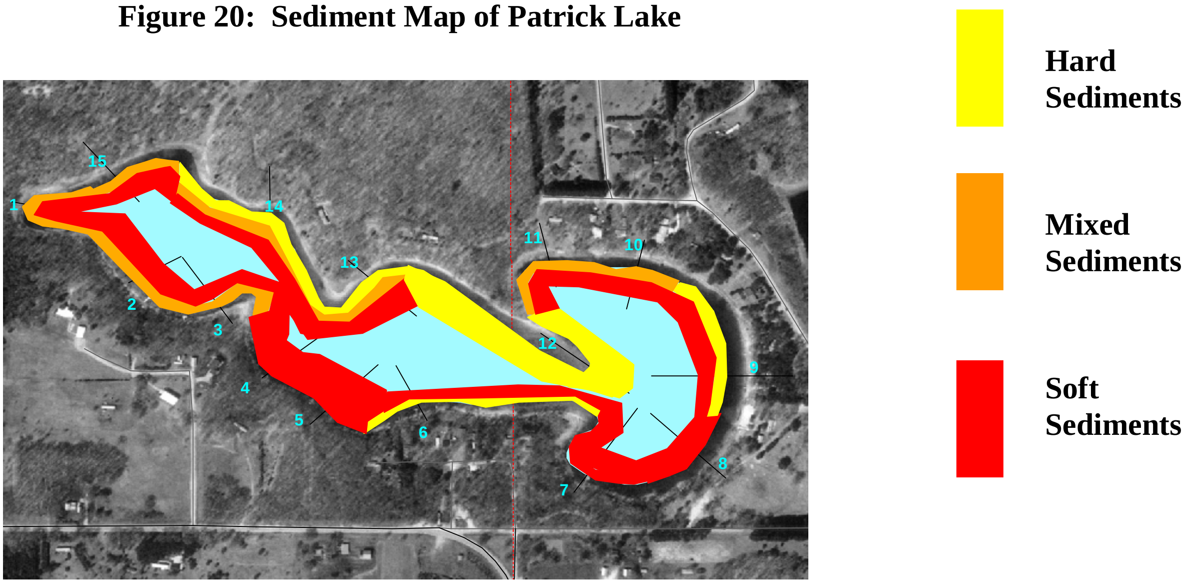
	current	-10%	-25%	-50%
Non-Irrigated Agriculture	30.80	27.72	23.10	15.40
Residential	19.80	17.82	14.85	9.90
Woodlands	19.80	19.80	19.80	19.80
Ground Watershed	24.20	21.78	18.15	12.10
Lake Surface	6.60	6.60	6.60	6.60
Septics	10.38	9.35	7.79	5.19
total in pounds/acre	111.58	103.07	90.29	68.99

Reducing the amount of input from the surface and ground watersheds results in less nutrient loading into the lake itself. Under the modeling predictions, reducing phosphorus inputs from human-based activities even 10% could improve Patrick Lake water quality by up to 4.9 micrograms. A 25% reduction could save up to 12.25 micrograms/liter, substantially under the 30 micrograms/liter recommended to avoid nuisance algal blooms. These predictions make it clear that reducing current phosphorus inputs to the lake are essential to improve, maintain and protect Patrick Lake's health for future generations.



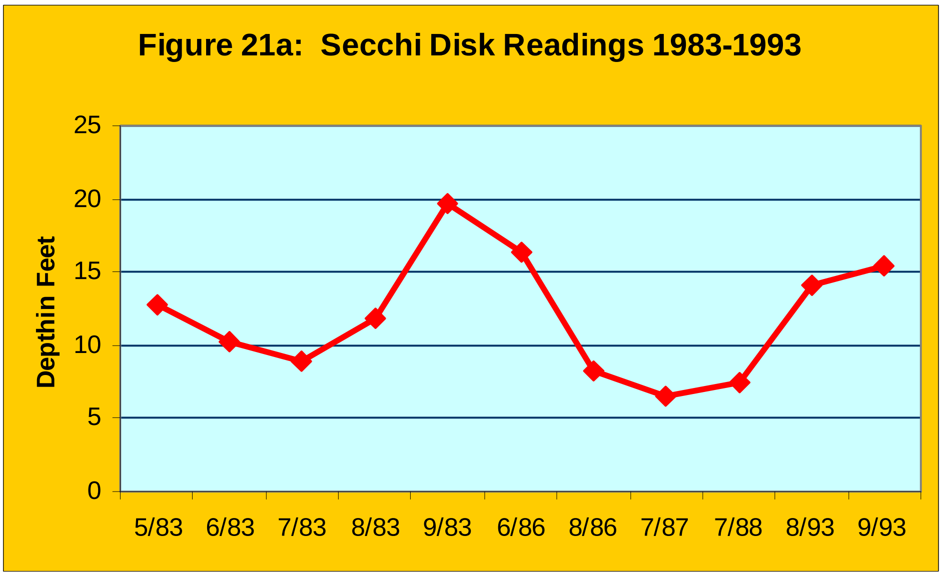
In most lakes in Wisconsin, phosphorus concentration in the bottom sediments of the lake is considerably higher than the concentration in the water column itself. Bottom sediments can "bind up" phosphorus, making it unavailable for aquatic plants or algae to use. Some sediment types hold phosphorus at a higher rate than others. As the sediment ma (Figure 20) shows, most of the sediment in Patrick Lake is soft, generally able to support significant aquatic plant growth

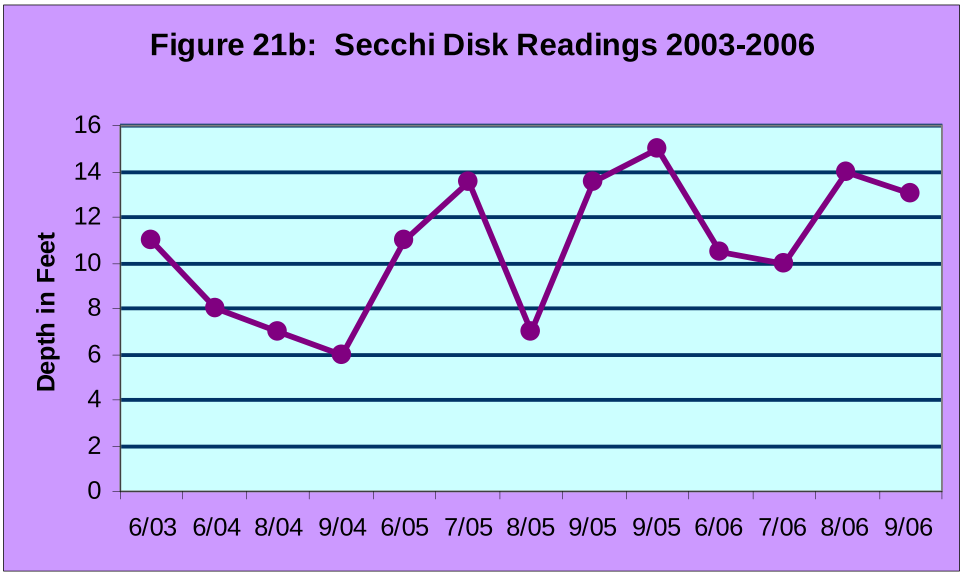
Figure 20: Sediment Map of Patrick Lake



Water Clarity

Water clarity is a critical factor for plants. If plants don't get more than 2% of the surface illumination, they won't survive. Water clarity can be reduced by turbidity (suspended materials such as algae and silt) and dissolved organic chemicals that color or cloud the water. Water clarity is measured with a Secchi disk. Average summer Secchi disk clarity in Patrick Lake in 2004-2006 was 10.2 feet. This is very good water clarity.





Patrick Lake has a spotty history of Secchi disk readings in a number of years. A look at the average Secchi depth for the growing season in each year since 1992 reveals fairly steady water clarity (see figure 22). The overall average depth for the years for which there are records is 10.6 feet.

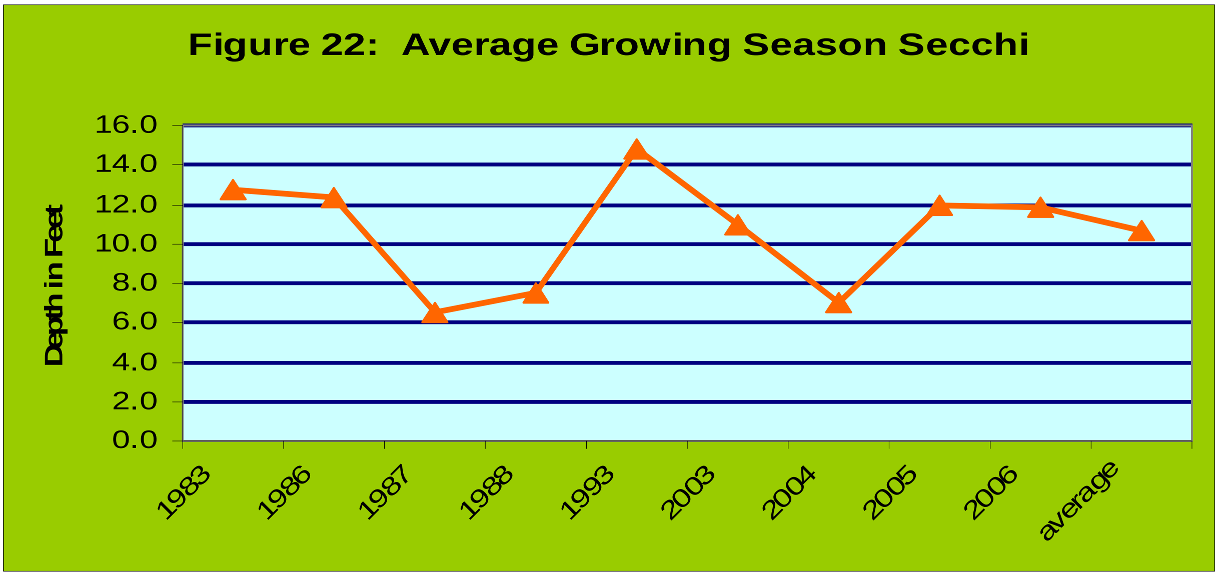


Figure 23: Photo of Testing Water Clarity with Secchi Disk

Chlorophyll a

Chlorophyll-a concentrations provide a measurement of the amount of algae in a lake's water. Algae are natural and essential in lakes, but high algal populations can increase water turbidity and reduce light available for plant growth, as well as result in unpleasing odor and appearance. Studies have shown that the amount of chlorophyll a in lake water depends greatly on the amount of algae present; therefore, chlorophyll-a levels are commonly used as a water quality indicator. The 2004-2006 growing season (June-September) average chlorophyll concentration in Patrick Lake was 2.8 micrograms/liter. Such an algae concentration places Patrick Lake at the "very good" level for chlorophyll a results. Chlorophyll-a averages remained fairly in all the years for which there are records, with an average level of 3.46 micrograms/liter covering from 1993 through 2006.

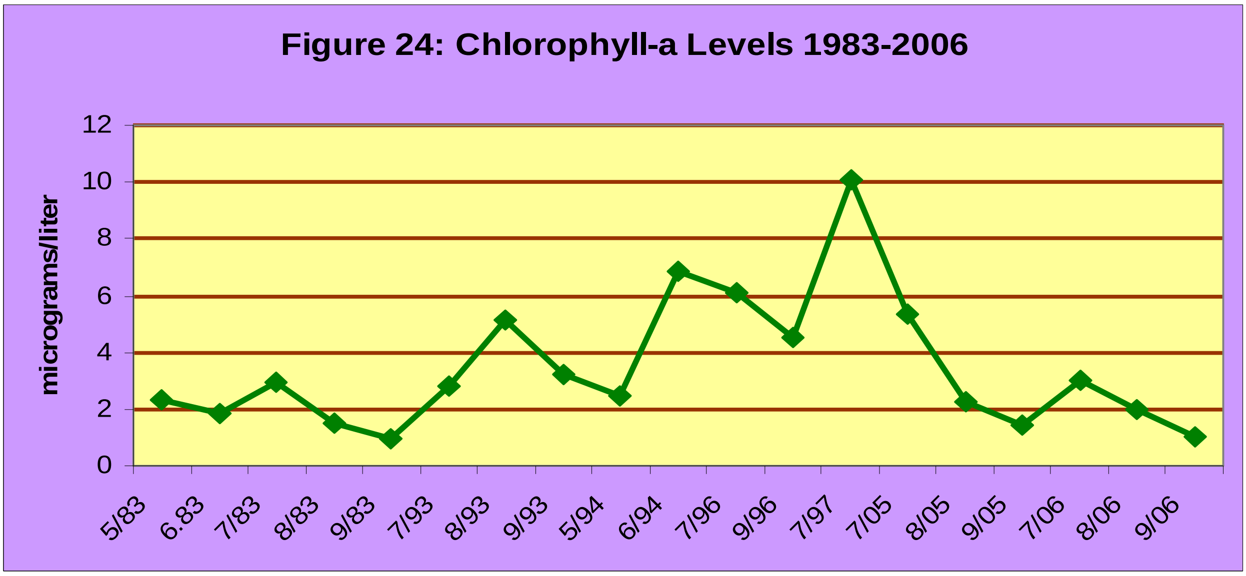


Figure 25: Photo of a Lake in Algal Bloom

Dissolved Oxygen

Oxygen dissolved in the water is essential to all aerobic aquatic organisms. The oxygen in a lake comes from the atmosphere and from the process of photosynthesis. Aquatic plants and algae consume carbon dioxide and respirate oxygen back into the lake water. The distribution of oxygen within a lake is affected by many factors, including water circulation, water stratification, winds or storms, air temperature; water temperature, nutrient availability, and the density and location of algae and/or aquatic plants. Historically, Patrick Lake had problems with low oxygen in the winter and frequent winterkills of fish. These problems eased after the installation of two aerators for winter use in 1974.

Oxygen consumption in the sediment and the water just above it (hypolimnion) is more sensitive that those in the two upper layers of water (metalimnion and epilimnion) because the bottom consumption is less likely to be balanced by the circulation and photosynthesis output available to the upper layers.

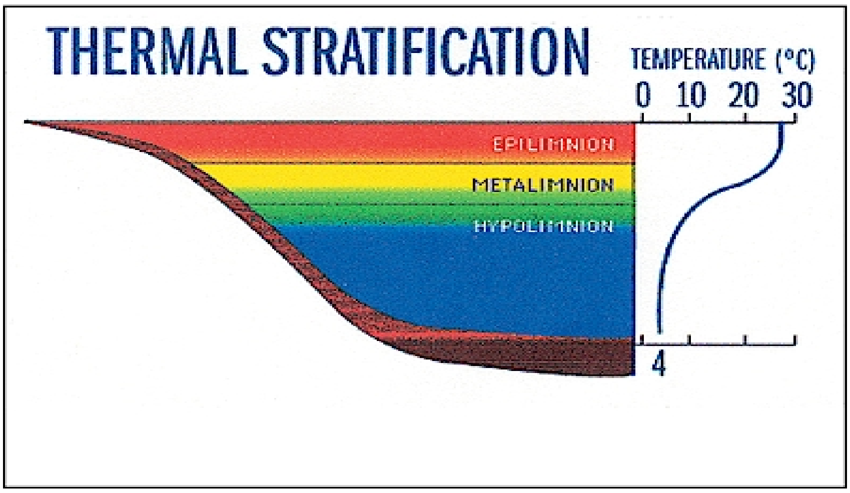


Figure 26: Stratification Layers found in Patrick Deep Holes

Low oxygen during the summer in the bottom waters of a lake occurs naturally as oxygen in the bottom layer is consumed, but not replenished. It is common that as the summer progresses, the oxygen concentration of the bottom waters decreases. Even with the aerator, Patrick Lake had were hypoxic periods in the lower depths during the summers of 2005 and 2006. In June 2005, oxygen concentration at 15 feet deep was only 4.1 milligrams/liter. In June 2006, dissolved oxygen levels were 3.43 milligrams/liter at 15 feet.

The charts (Figures 27a, 27b, 27c) below show the annual variations in dissolved oxygen levels in milligrams/liter, depth in feet and months of the year for 1995-2004, 20045, and 2006.

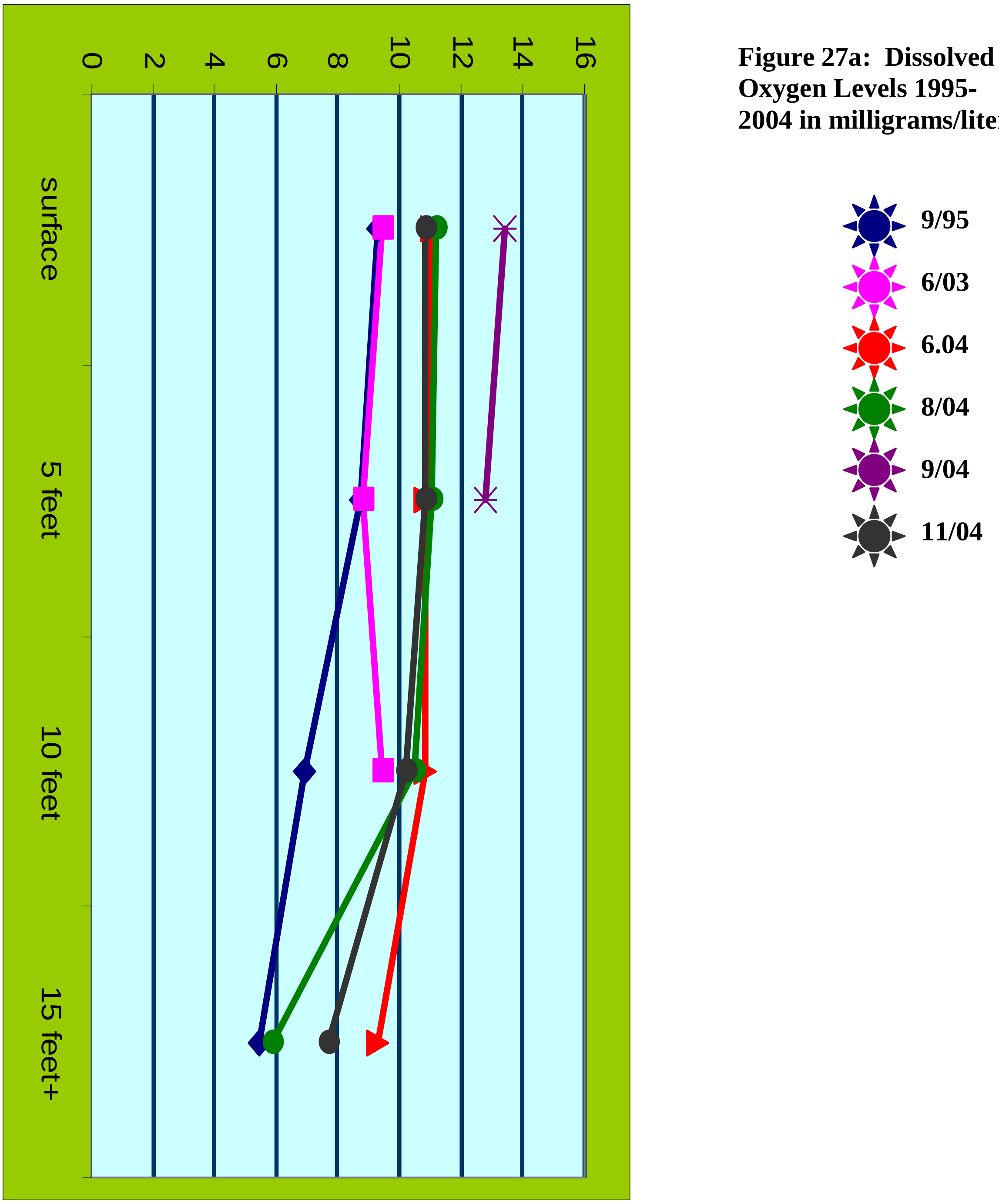
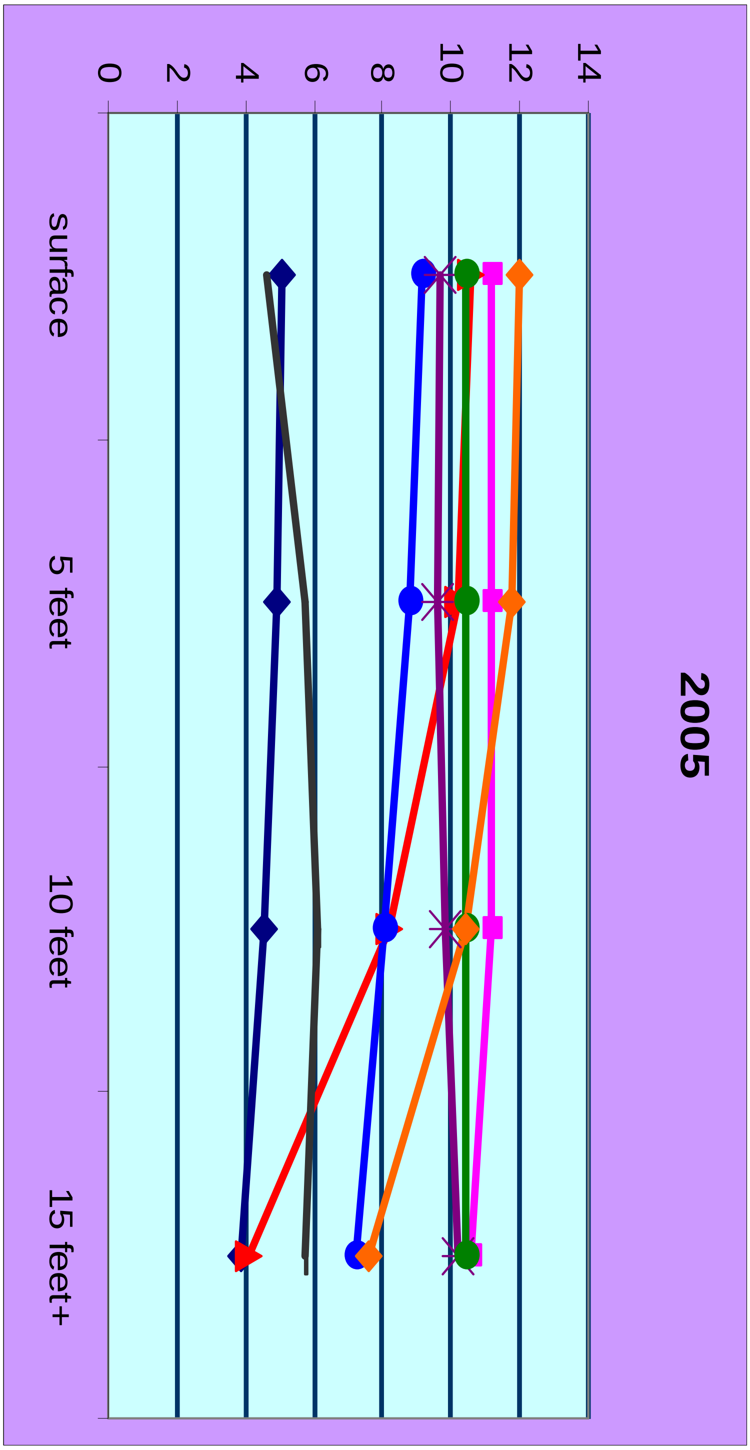


Figure 27a: Dissolved Oxygen Levels 1995-2004 in milligrams/liter

Figure 27b: Dissolved Oxygen Levels During 2005 Water Testing in milligrams/liter

2/05
4/05
6/05
7/05
8/05
9/05
9/05
11/05



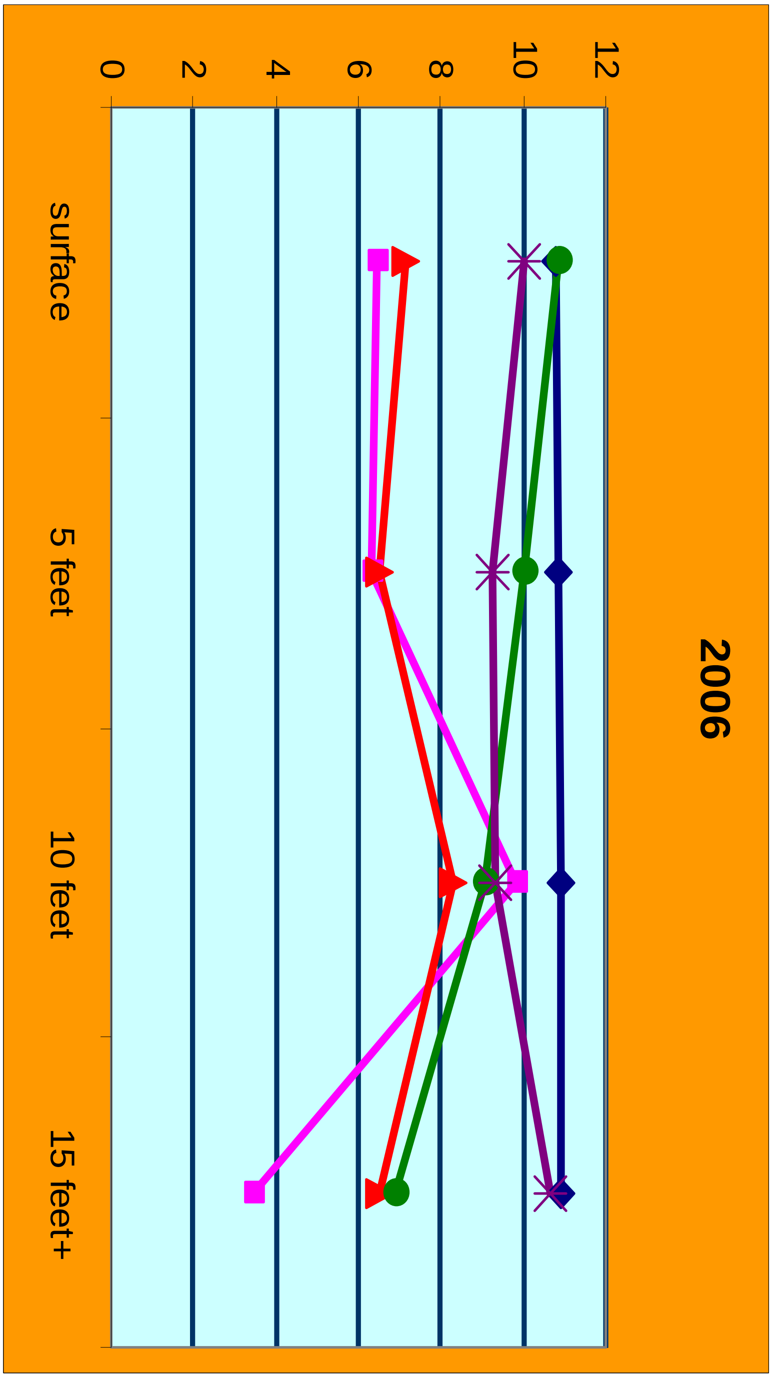
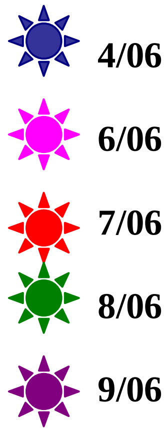


Figure 27c: Dissolved Oxygen Levels During 2006Water Testing in milligrams/liter



In deeper lakes, when the surface waters have cooled in autumn and water density throughout the water column is the same, the water column mixes vertically, a process known as “fall turnover.” Most of Patrick Lake is shallow and does not stratify. However, in the deeper areas of the center lobe, the lake does stratify and turns over in the spring and fall.

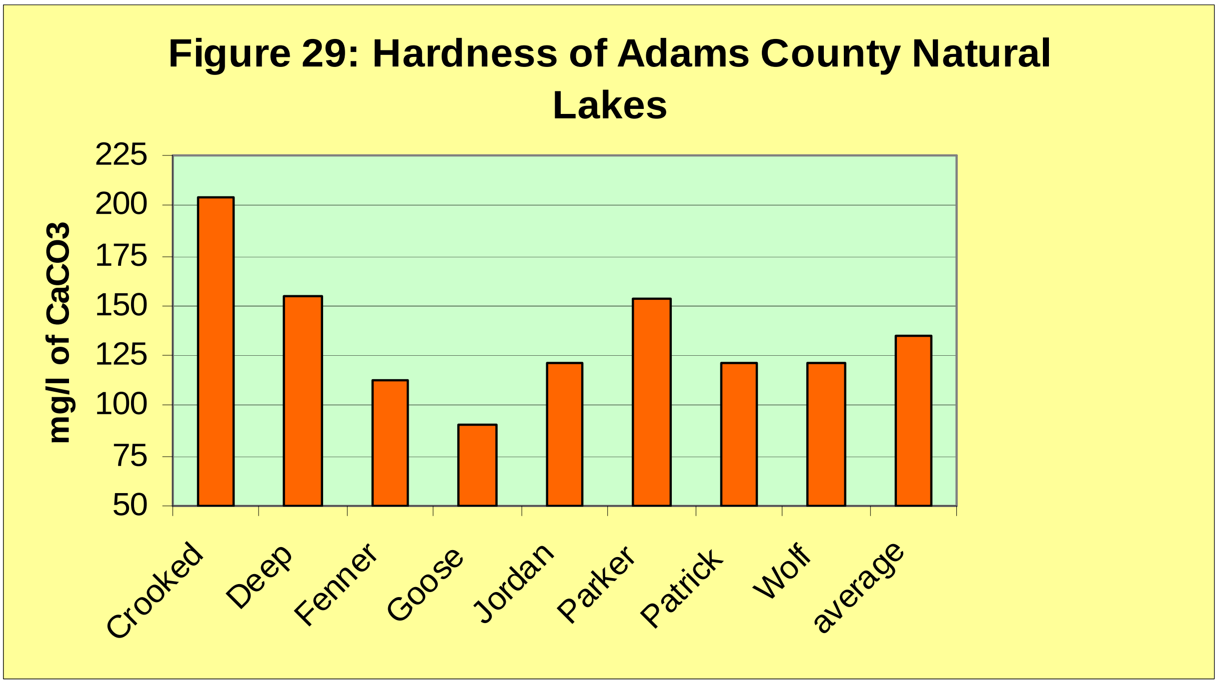
Water Hardness, Alkalinity and pH

Testing done by Adams County LWCD on Patrick Lake included annual testing for water alkalinity and water hardness. Hardness and alkalinity levels in a lake are affected by the soil minerals, bedrock type in the watershed, and frequency of contact between lake water & these materials.

Level of Hardness	Milligrams/liter CaCO3
SOFT	0-60
MODERATELY HARD	61-120
HARD	121-180
VERY HARD	>180

Figure 28: Hardness Table

One method of evaluating hardness is to test the water for the amount of calcium carbonate ($CaCO_3$) it contains. The surface water of all of the public access lakes in Adams County have water that is moderately hard to very hard, whether they are impoundments (man-made lakes) or natural lakes. In 2005 and 2006, random samples were also taken of wells around Patrick Lake to measure the hardness of the water coming into the lake through groundwater. Hardness in the groundwater averaged 276 milligrams/liter (very hard). This is considerably more than the surface water average of 109 milligrams/liter (moderately hard). The hardness in both surface and groundwater is likely due to the underlying bedrock in Adams County, which is mostly sandstone with pockets of dolomite and shale.



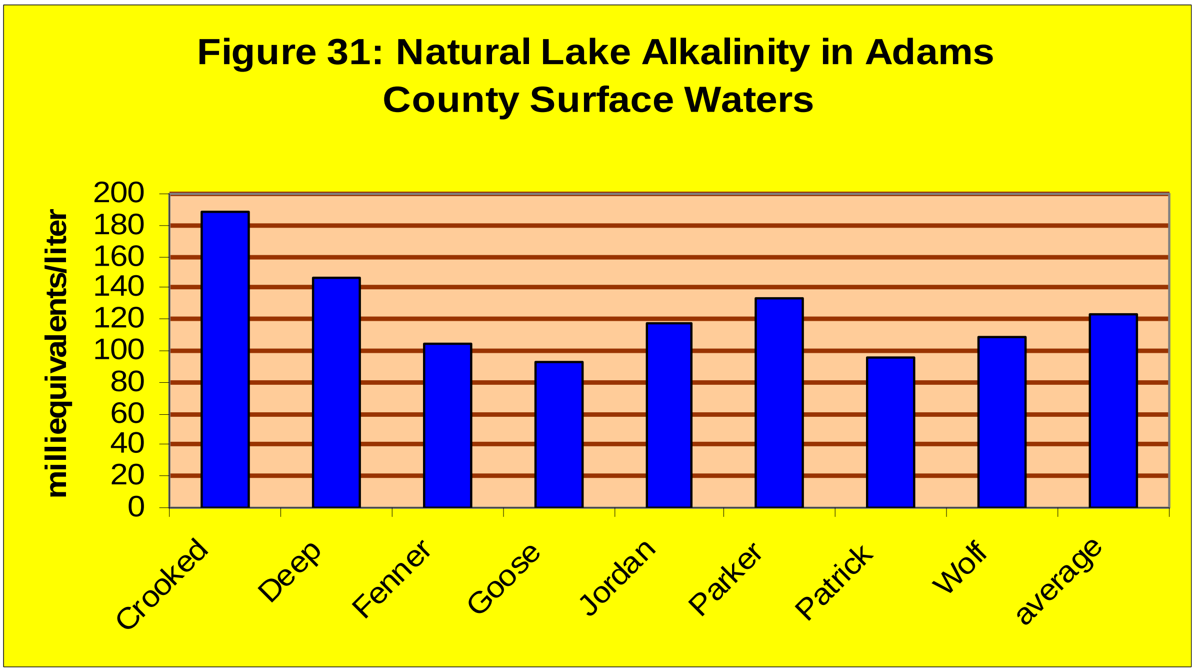
Patrick Lake's surface water hardness of 109 milligrams/liter was considerably below the overall hardness average for natural lakes in Adams County of 135.3 milligrams/liter of Calcium Carbonate, although slightly higher than the 1983 figure of 102.4 milligrams/liter. Hard water lakes tend to produce more fish and aquatic plants than soft water lakes because they are often located in watersheds with soils that load phosphorus into the lake water.

Alkalinity is important in a lake to buffer the effects of acidification from the atmosphere. "Acid rain" has long been a problem with lakes that had low alkalinity level and high potential sources of acid deposition.

Acid Rain Sensitivity	ueq/l CaCO3
High	0-39
Moderate	49-199
Low	200-499
Not Sensitive	>500

Figure 30: Acid Rain Sensitivity

Patrick Lake watersheds well water testing results averaged of 182 milliequivalents/liter. This is higher than the surface water alkalinity average of 95 milliequivalents/liter and higher than the alkalinity average for natural lakes in Adams County of 123.8 millieqivalents/liter. In 1993, surface water alkalinity tested at 92.3 milliequivalents/liter, close to the current figure. Patrick Lake's potential sensitivity to acid rain remains moderate, but luckily for Adams County, the acid deposition rate is very low, probably due to the little industrialization in the county.



Alkalinity also affects the pH level of lake water. The acidity level of a lake's water regulates the solubility of many minerals. A pH level of 7 is neutral. The pH level in Wisconsin lakes ranges from 4.5 in acid bog lakes to 8.4 in hard water, marl lakes.

Some of the minerals that become available under low pH, especially the metals aluminum, zinc and mercury, can inhibit fish reproduction and/or survival. Even what seems like a small variance in pH can have large effects because the pH scale is set up so that every 1.0 unit change increases acidity tenfold, i.e., water with a pH of 7 is 10 times more acid than water with pH of 8. Mercury and aluminum are not only toxic to many kinds of wildlife; they can also be toxic to humans, especially those that eat tainted fish.

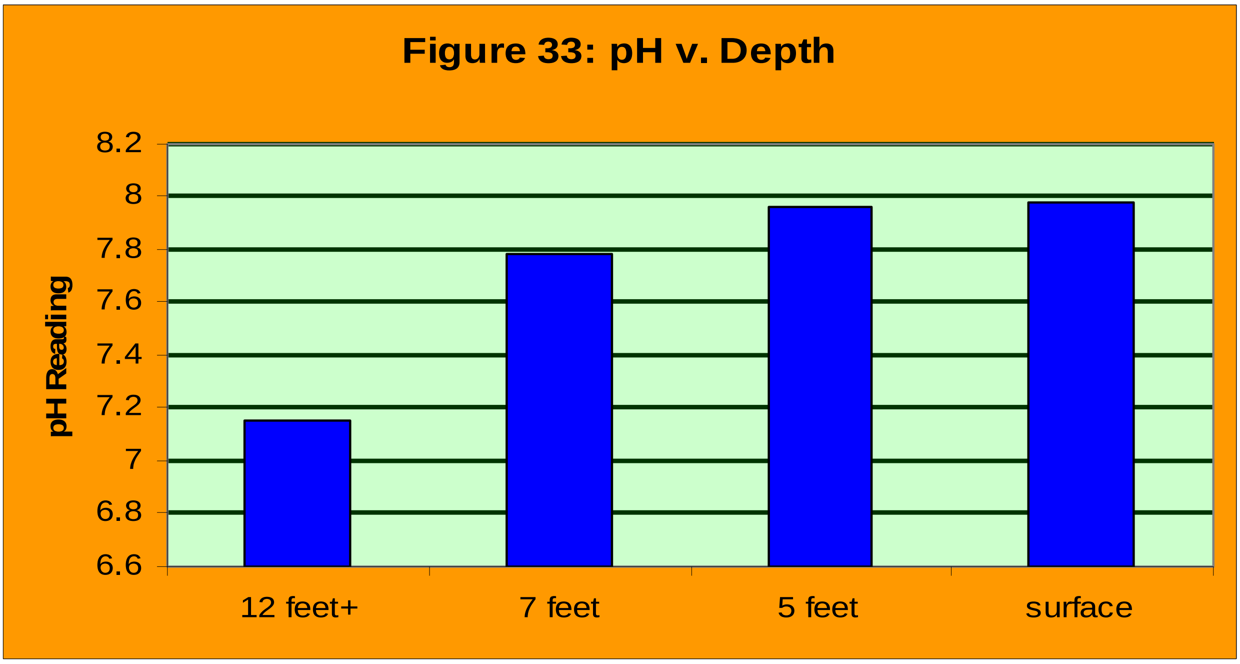
The testing occurring from 2004-2006 also included regular monitoring of the pH at several depths in Patrick Lake. As is common in the lakes in Adams County, Patrick Lake has pH levels starting at just about neutral (7.15) at 15 feet depth and increasing in alkalinity as the depth gets less, until the surface water pH averages 7.98. A lake's pH level is important for the release of potentially harmful substances and also affects plant growth, fish reproduction and survival. Most plants grow best at pH levels between 5.5 and 8.

More importantly for many lakes, fish reproduction and survival are very sensitive to pH levels. The chart below indicates the effect of pH levels under 6.5 on fish (Figure 32):

Figure 32: Effects of pH Levels on Fish

Water pH	Effects
6.5	walleye spawning inhibited
5.8	lake trout spawning inhibited
5.5	smallmouth bass disappear
5.2	walleye & lake trout disappear
5	spawning inhibited in most fish
4.7	Northern pike, sucker, bullhead, pumpkinseed, sunfish & rock bass disappear
4.5	perch spawning inhibited
3.5	perch disappear
3	toxic to all fish

No pH levels taken in Patrick Lake between 2004-2006 fell below the pH level that inhibits walleye reproduction. A lake with a neutral or slightly alkaline pH like Patrick Lake is a good lake for fish and plant survival. Natural rainfall in Wisconsin averages a pH of 5.6. This means that if the rain falls on a lake without sufficient alkalinity to buffer that acid water coming in by rainfall, the lake's fish cannot reproduce. That is not a problem at Patrick Lake. Patrick Lake has a good pH level for fish reproduction and survival.



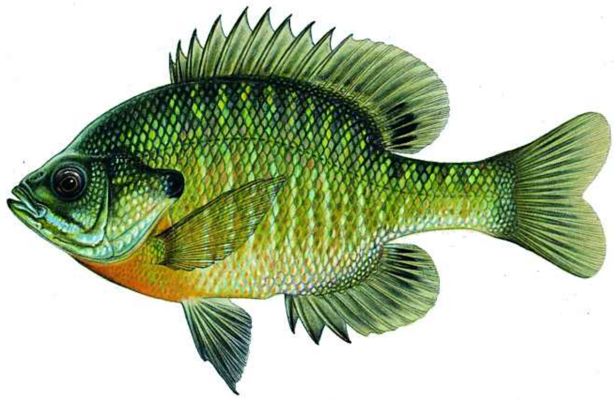


Figure 34a: Abundant fish in Patrick Lake—Bluegill (*Lepomis macrochirus)*

Figure 34b: Abundant Fish in Patrick Lake—Pumpkinseed (*Legomis gibbosus))*

Other Water Quality Testing Results

CHLORIDE: Chloride does not affect plant and algae growth and is not known to be harmful to humans. It isn't common in most Wisconsin soils and rocks, so is usually found only in very low levels in Wisconsin lakes. However, the presence of a significant amount of chloride over a period of time indicates there may be negative human impacts on the water quality present from septic system failure, the presence of fertilizer and/or waste, deposition of road-salt, and other nutrients. An increased chloride level is thus an indication that too many nutrients are entering the lake, although the level has to be evaluated compared to the natural background data for chloride. The average chloride level found in Patrick Lake during the testing period 6.67 milligrams/liter, over twice the natural level of chloride of 3 milligrams/liter in this area of Wisconsin This elevated level warrants monitoring and investigation to determine the source of the elevated chloride levels.

NITROGEN: Nitrogen is necessary for plant and algae growth. A lake receives nitrogen in various forms, including nitrate, nitrite, organic, and ammonium. In Wisconsin, the amount of nitrogen in a lake's water often corresponds to the local land use. Although some nitrogen will enter a lake through rainfall from the atmosphere, that coming from land use tends to be in higher concentrations in larger amounts, coming from fertilizers, animal and human wastes, decomposing organic matter, and surface runoff. For example, the growth level of the exotic aquatic plant, Eurasian Watermilfoil (*Myriophyllum spicatum*) has been correlated with fertilization of lake sediment by nitrogen-rich spring runoff.

Nitrogen levels can affect other aspects of water quality. The sum of water testing results for nitrate, nitrite and ammonium levels of over .3 milligrams/liter in the spring can be used to project the likelihood of an algal bloom in the summer (assuming sufficient phosphorus is also present). Patrick Lake combination spring levels from 2004 to 2006 averaged 0/09 milligrams/liter, far below the .3 milligrams/liter predictive level for nitrogen-related algal blooms. These elevations suggest that any algal blooms on Patrick Lake may be are probably not nitrogen-related.

CALCIUM and MAGNESIUM: Calcium is required by all higher plants and some microscopic lifeforms. Magnesium is needed by chlorophyllic plants and by algae, fungi and bacteria. Both calcium and magnesium are important contributors to the hardness of a lake's waters. Magnesium elevated about 125 milligrams/liter may have a laxative effect on some humans. Otherwise, no health hazards to humans and wildlife are known from calcium and magnesium. The average Calcium level in Patrick Lake's water during the testing period was 24.04 milligrams/liter. The average Magnesium level was 13.75 milligrams/liter. Both of these are low-level readings.

SODIUM AND POTASSIUM: These elements occur naturally only in low levels in Wisconsin waters and soils. Their presence may indicate human-caused pollution. Sodium is found with chloride in many road salts and fertilizers and is also found in human and animal waste. Potassium is found in many fertilizers and also found in animal waste. The level of these two is generally not useful as a specific pollution indicator, but increasing levels or one or both of these elements can indicate possible contamination from damaging pollutants. High levels of sodium have also been found to influence the development of a large population of cyanobacteria, some of which can be toxic to animals and humans. Some health professionals have suggested that sodium levels over 20 milligrams/liter may be harmful to heart and kidney patients if ingested. Both sodium and potassium levels in Patrick Lake are very low: the average sodium level was 0.85 milligrams/liter; the average potassium reading 0.18 milligrams/liter.

SULFATE: In low-oxygen waters (hypoxic), sulfate can combine with hydrogen and becomes the gas hydrogen sulfate, which smells like rotten eggs and is toxic to most aquatic organisms. Sulfate levels can also affect the metal ions in the lake, especially iron and mercury, by binding them up, thus removing them from the water column. To prevent the formation of hydrogen sulfate, levels of 10 milligrams/liter are best. A health advisory kicks in at 30 milligrams/liter. Patrick Lake sulfate levels averaged 12.41 milligrams/liter during the testing period, above the level for hydrogen sulfate formation, but below the health advisory level.

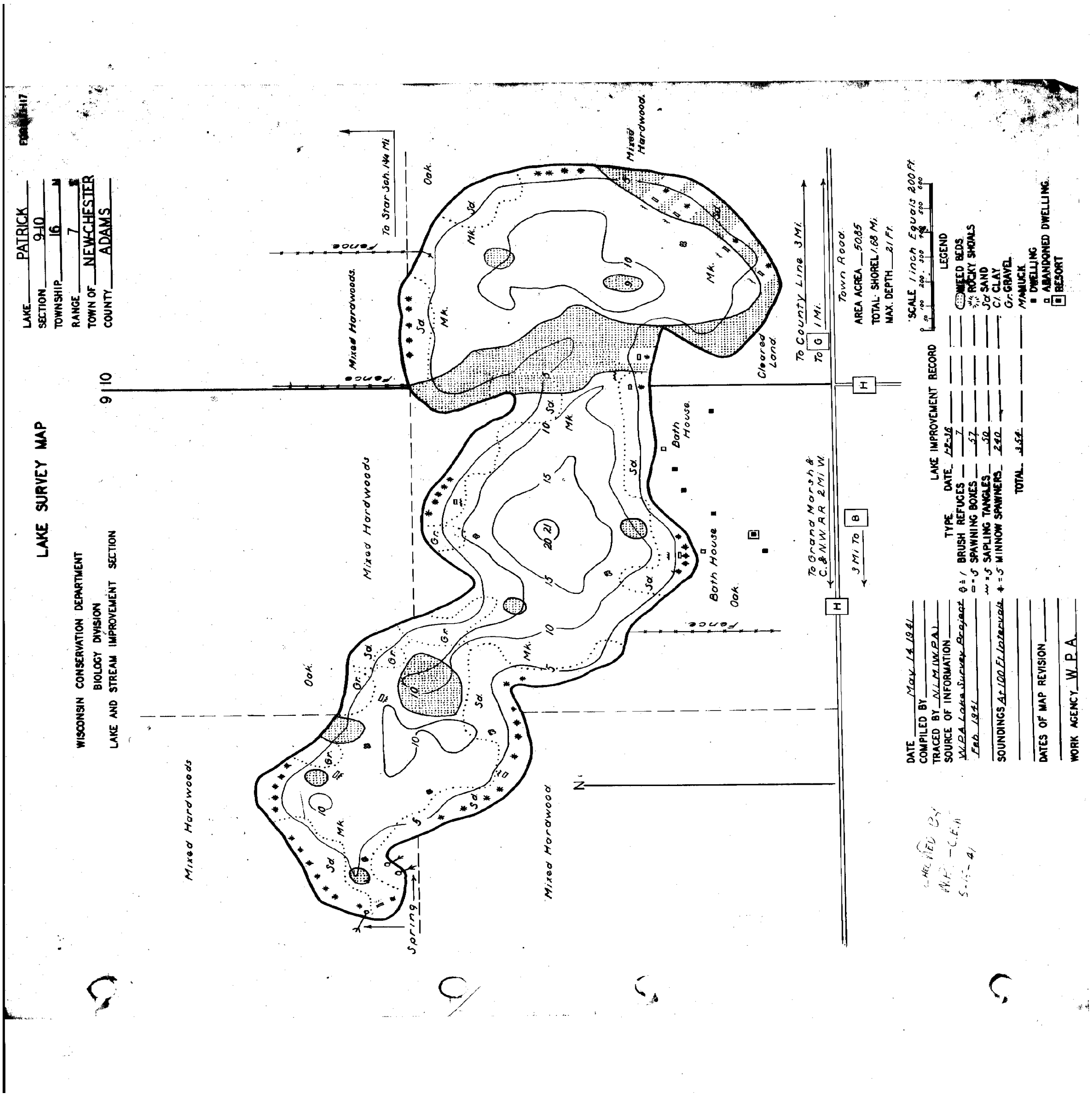
TURBIDITY: Turbidity reflects water clarity. The term refers to suspended solids in the water column—solids that may include clay, silt, sand, plankton, waste, sewage and other pollutants. Turbid water may mask the presence of bacteria or other pollutants because the water looks murky or muddy. In general, turbidity readings of less than 5 NTU are best. Very turbid waters may not only smell, but also tend to be aesthetically displeasing, thus curtailing recreational uses of the water. Turbidity levels for Patrick Lake's waters were: 2.6 NTU in 2004, 2.22 NTU in 2005 and 2.04 NTU in 2006—all below the level of concern.

Figure 35: Examples of Very Turbid Water

HYDROLOGIC BUDGET

According to a 1941 WDNR bathymetric (depth) map, Patrick Lake has 50.85 surface acres, with a maximum depth of 21 feet. Considering the loss of lake level in the past few years, those figures have probably decreased.

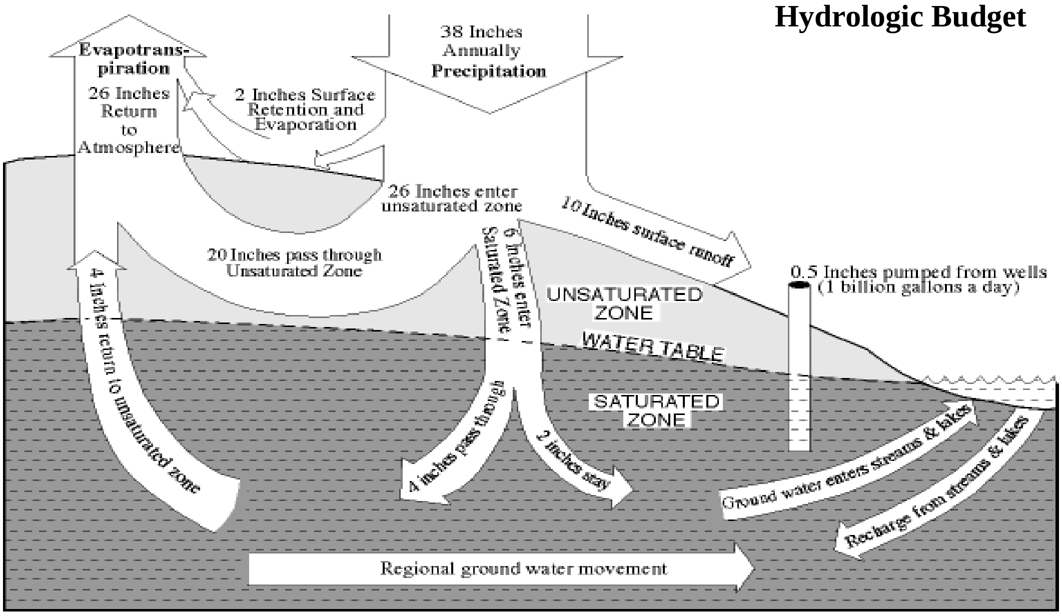
Figure 36: Bathymetric Map of Patrick Lake



A "hydrologic budget" is an accounting of the inflow to, outflow from and storage in a hydrological unit (such as a lake). "Residence time" is the average length of time particular water stays within a lake before leaving it. This can range from several days to years, depending on the type of lake, amount of rainfall, and other factors. "Flushing rate" is the time it takes a lake's volume to be replaced. "Annual runoff volume", as used in WiLMS, is the total water yield from the drainage area reaching the lake. The "drainage area" is the amount of area (in acres) contributing surface water runoff and nutrients to the lake. The "areal water load" is the total annual flow volume reaching the lake divided by the surface area of the lake. "Hydraulic loading" is the total annual volume of all water sources (including precipitation, non-point sources & point sources) loading into the lake.

Using the data gathered from historical testing and that done by the Adams County LWCD from 2004-2006, the WiLMS model calculated the tributary drainage area for Patrick Lake as 1509 acres. The average unit runoff for Adams County in the Patrick Lake area is 9.4 inches. WiLMS determined the expected annual runoff volume as 1182.1 acre-feet/year. Anticipated annual hydraulic loading is 1182.1 acre-feet/year. Areal water load is 23.6 feet/year. Residence time is 0.26 year. Lake flushing rate is 3.81 1/year.

Figure 37: Example of Hydrologic Budget



TROPHIC STATE

The trophic state of a lake is one measure of water quality, basically defining the lake's biological production status (see Figure 38). **Eutrophic lakes** are very productive, with high nutrient levels, frequent algal blooms and/or abundant aquatic plant growth. **Oligotrophic lakes** are those low in nutrients with limited plant growth and small populations of fish. **Mesotrophic lakes** are those in between, i.e., those which have increased production over oligotrophic lakes, but less than eutrophic lakes; those with more biomass than oligotrophic lakes, but less than eutrophic lakes; often with a more varied fishery than either the eutrophic or oligotrophic lakes. In comparing water quality testing results with the prediction from the computer modeling of this modeling with the actual figures outlined above, the actual Trophic State of Patrick Lake is what was predicted from the modeling. Modeling results predicted that the overall TSI for Patrick Lake would be **42**. This score places Patrick Lake's overall TSI at below average for natural lakes in Adams County (43.88)—which is good, since with TSI, the lower the score, the better.

Figure 38: Trophic Status Table

Patrick Lake = 42

Score	TSI Level Description
30-40	**Oligotrophic:** clear, deep water; possible oxygen depletion in lower depths; few aquatic plants or algal blooms; low in nutrients; large game fish usual fishery
40-50	**Mesotrophic:** moderately clear water; mixed fishery, esp. panfish; moderate aquatic plant growth and occasional algal blooms; may have low oxygen levels near bottom in summer
50-60	**Mildly Eutrophic:** decreased water clarity; anoxic near bottom; may have heavy algal bloom and plant growth; high in nutrients; shallow eutrophic lakes may have winterkill of fish; rough fish common
60-70	**Eutrophic:** dominated by blue-green algae; algae scums common; prolific aquatic plant growth; high nutrient levels; rough fish common; susceptible to oxygen depletion and winter fishkill
70-80	**Hypereutrophic:** heavy algal blooms through most of summer; dense aquatic plant growth; poor water clarity; high nutrient levels

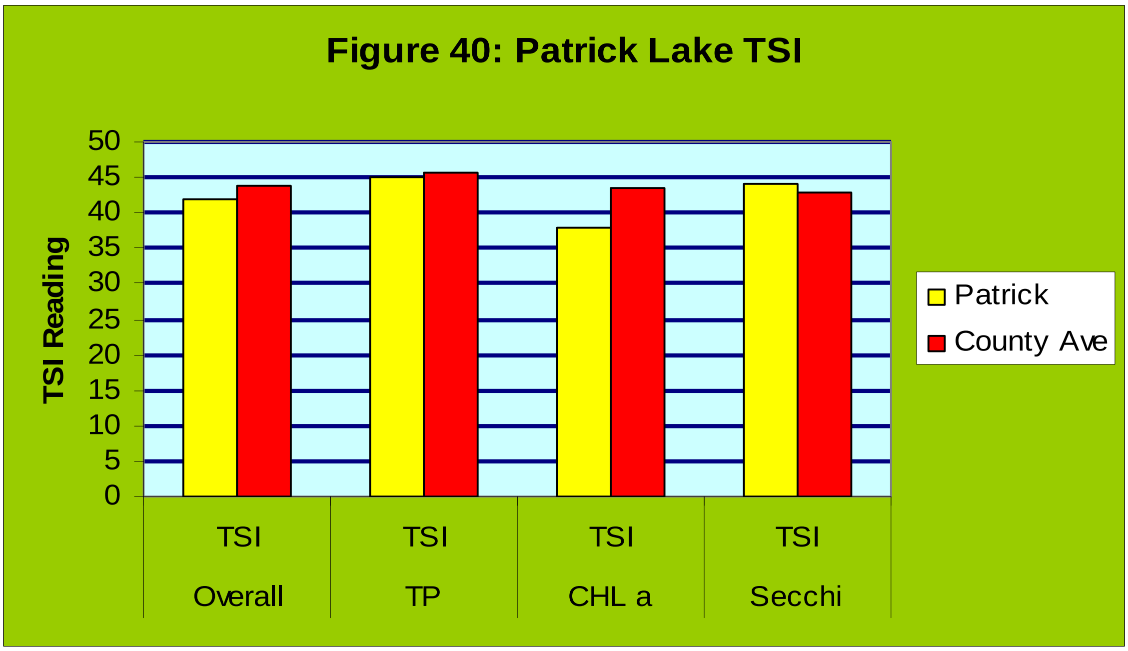
Phosphorus concentration, chlorophyll-a concentration and water clarity data are collected and combined to determine a trophic state. As discussed earlier, the average 2004-2006 growing season epilimnetic total phosphorus for Patrick Lake was 17.3

micrograms/liter. The average growing season chlorophyll-a concentration was 4.98 micrograms/liter. Growing season water clarity averaged a depth of 10.2 feet. Figure 40 shows where each of these measurements from Patrick Lake fall in trophic level.

Figure 39: Patrick Lake Trophic Status Overview

Trophic State	Quality Index	Phosphorus	Chlorophyll a	Sechhi Disk
		(ug/l)	(mg/l)	(ft)
Oligotrophic	Excellent	<1	<1	>19
	Very Good	1 to 10	**1 to 5**	**8 to 19**
Mesotrophic	Good	**10 to 30**	5 to 10	6 to 8
	Fair	30 to 50	10 to 15	5 to 6
Eutrophic	Poor	50 to 150	15 to 30	3 to 4
Patrick Lake		**17.3**	**2.8**	**10.2**

These figures show that Patrick Lake has fair to good levels overall for the three parameters often used to described water quality: Secchi disk depths; average TP for the growing season; and chlorophyll a levels. It is normal for all of these values to fluctuate during a growing season. However, they can be affected by human use of the lake, by summer temperature variations, by algae growth & turbidity, and by rain or wind events.



IN-LAKE HABITAT

Aquatic Plants

A healthy aquatic plant community plays a vital role within the lake community. This is due to the role plants play in improving water quality, providing valuable habitat resources for fish and wildlife, resisting invasions of non-native species and checking excessive growth of the most tolerant species.

In 2005, a qualitative aquatic plant survey was done on Patrick Lake by staff from WDNR and Adams County Land & Water Conservation Department. As noted earlier, abbreviated aquatic plant surveys were done in 1983 and 1993. An aquatic plant survey was also done in 2004 by a private consulting firm, using a different method than the one done in 2005.

The 1983 survey found 15 native aquatic species, including 14 plants and one macrophytic (plant-like) alga, *Chara* spp. Of the plant species found, 2 were emergent species, 4 were floating-leaf plants, and 8 were submergent. In the 1993 survey, at least 9 aquatic plant species were found, including 2 emergent species, 3 floating-leaf species, and 4 submergent species. Among the emergent species was *Potamogeton crispus* (curly-leaf pondweed), an invasive exotic aquatic plant species. The 2004 aquatic plant survey, done in September 2004, found 15 aquatic plant species, including 3 floating-leaf plant species and 12 submergent species. The invasive *Myriophyllum spicatum* (Eurasian Watermilfoil) was found in high frequency. No emergent species were found, perhaps due to the lateness of the survey.

The 2005 aquatic plant survey found that the Patrick Lake aquatic plant community colonized approximately three-quarters of the entire lake area to a maximum rooting depth of 13 feet. Within the important shallow water littoral zone, 100% of the sites were vegetated. The 0-1.5ft depth zone supported the most abundant aquatic plant growth. The aquatic plant community is characterized by high quality, good species diversity, an average sensitivity to disturbance and a condition closer than average to an undisturbed condition.

The Aquatic Macrophyte Community Index (AMCI) for Patrick Lake was 58, indicating that the quality of the plant community in Patrick Lake is high, in the top quartile of lakes in Wisconsin and the North Central Hardwoods Region. Simpson's Diversity Index (0.876) indicates that the aquatic plant community had a good diversity of plant species.

The Average Coefficient of Conservatism and the Floristic Quality Index indicate that Patrick Lake has an average sensitivity to disturbance and is closer to an undisturbed condition than the average lake in the state or region.

The aquatic plant community is characterized by very good species diversity for both the North Central Hardwood Forest Region and all Wisconsin lakes The aquatic plant community in Patrick Lake is in the category of those closer to disturbance and more tolerant of disturbance than the average lake in the North Central Hardwood Region and Wisconsin Lakes overall. Disturbances include invasions of exotic species, boat traffic, shoreline development, harvesting and past herbicide treatments.

Najas guadalupensis was the most frequently occurring species in Patrick Lake in 2005. *Chara* spp., *Nymphaea odorata, Potamogeton illinoensis,* and *Potamogeton richardsonii* were also commonly occurring species. *Najas guadalupensis* was the species with the highest mean density in Patrick Lake. *Najas guadalupensis* had a high "mean density where present", indicating that where *Najas. guadalupensis* occurred, it exhibited a growth form of above average density in Patrick Lake. *Chara* spp. and *Nymphaea odorata* also had high "densities where present", so also exhibited an aggregated growth form or a growth form of above average density.

Combining the relative frequency and relative density of a species into a Dominance Value illustrates how dominant that species is within the aquatic plant community. Based on the Dominance Value, *Najas guadalupensis* was the overall dominant aquatic plant species in Patrick Lake. *Chara* spp. was sub-dominant overall. *Najas guadalupensis* was the dominant species overall and was dominant in the 1.5-10 foot depth zones. *Najas guadaluepnsis* occurred at its highest frequency and density in the 1.5-10 foot depth zone. *Nymphaea odorata* was the dominant species in the 0-1.5 foot depth zone, occurring at its highest frequency and density in this depth zone. *Potamogeton praelongus* was the dominant species in the 10-20 foot depth zone, occurring at its highest frequency and density in this depth zone.

Of the 17 aquatic species found in Patrick Lake in 2005, 15 were native aquatic plants. 2 species were macrophytic-algae (*Chara* and *Nitella*). In the native plant category, 3 were emergent plants, 3 were floating-leaf rooted plants, and 9 were submergent species. The exotic invasive found in 2004, *Myriophyllum spicatum* (Eurasian Watermilfoil), wasn't found in 2005, most likely because chemical treatment for it had occurred in May 2005. The dominant and common plant species were found throughout the lake except one. *Potamogeton richardsonii* was found only in the south half of the lake. Filamentous algae were found at 34.04% of the sample sites.

Figure 41. Patrick Lake Aquatic Species--2005

Emergent Species	
1) *Carex* spp.	sedge
2) *Scirpus validus* Vahl.	softstem bulrush
3) *Typha* spp.	cattail
Floating-leaf Species	
4) *Brasenia schreberi* J. F. Gmelin.	watershield
5) *Nuphar variegata* Durand.	bull-head pond lily
6) *Nymphaea odorata* Aiton.	white water lily
Submergent Species	
7) *Chara* sp.	muskgrass
8) *Myriophyllum spicatum* L.	Eurasian water milfoil
9) *Najas flexilis* (Willd.) Rostkov & Schmidt.	slender naiad
10) *Najas guadalupensis* (Spreng.) Magnus.	common water-nymph
11) *Nitella* sp.	nitella
12) *Potamogeton amplifolius* Tuckerman.	large-leaf pondweed
13) *Potamogeton gramineus* L.	variable-leaf pondweed
14) *Potamogeton illinoensis* Morong.	Illinois pondweed
15) *Potamogeton natans* L.	floating-leaf pondweed
16) *Potamogeton praelongus* Wulf.	white-stem pondweed
17) *Potamogeton richardsonii* (Ar. Benn.) Rydb.	clasping-leaf pondweed

Since Eurasian Watermilfoil has had a high frequency of occurrence in the past, the Patrick Lake District will need to closely monitor its possible recurrence. Its tenacity and ability to spread to large areas fairly quickly make it an ongoing danger to the diversity, habitat value and equality of Patrick Lake's aquatic plant community. Also, Curly-Leaf Pondweed, another aquatic invasive plant, has been found previously in Patrick Lake. Monitoring for its recurrence should also occur.

The Average Coefficient of Conservatism and a Floristic Quality Index calculation were performed on the field results. Technically, the Average Coefficient of Conservatism measures the community's sensitivity to disturbance, while the Floristic Quality Index measures the community's closeness to an undisturbed condition. Indirectly, they measure past and/or current disturbance to the particular community.

Previously, a value was assigned to all plants known in Wisconsin to categorize their probability of occurring in an undisturbed habitat. This value is called the plant's Coefficient of Conservatism. A score of 0 indicates a native or alien opportunistic invasive plant. Plants with a value of 1 to 3 are widespread native plants. Values of 4 to 6 describe native plants found most commonly in early successional ecosystem. Plants scoring 6 to 8 are native plants found in stable climax conditions. Finally, plants with a value of 9 or 10 are native plants found in areas of high quality and are often rare, endangered or threatened. In other words, the lower the numerical value a plant has, the more likely it is to be found in disturbed areas.

The Average Coefficient of Conservatism in Patrick Lake in 2006 was 5.86. This makes it below average for Wisconsin Lakes (average 6.0), but higher than the average for lakes in the North Central Hardwood Region (average 5.6). The Floristic Quality Index of the aquatic plant community in Patrick Lake of 21.92 is above average for Wisconsin Lakes (average 22.2) and the North Central Hardwood Region (average 20.9). This suggests that the plant community in Patrick Lake is closer to an undisturbed condition than the average lake in Wisconsin overall for Floristic Quality, but closer to disturbance under its Average Coefficient of Conservatism. The major disturbances in Patrick Lake are likely the past broad-spectrum treatments of aquatic vegetation, the introduction of non-native aquatic plant species and the subsequent selective chemical treatments, shoreline development and fluctuating water levels

Since 100% of the lake bottom is vegetated, all the sediments in Patrick Lake hold sufficient nutrients to maintain aquatic plant growth. Due to the increasingly shallow depth of the lake, sunlight also encourages plant growth at all depths in the lake.

Patrick Lake has some protection from natural shoreline cover (wooded, shrub, native herbaceous growth), but disturbed shoreline covered at least one-fifth of the shore. Cultivated lawn was abundant and hard structures were commonly occurring at the disturbed shoreline sites.

Shorelines with cultivated lawn can impact the plant community through increased run-off of lawn fertilizers, pesticides and pet wastes into the lake. Hard structures and mowed lawn also speed run-off to the lake without filtering these pollutants. Expanding and protecting the buffer of natural vegetation along the shore will help prevent shoreline erosion and reduce additional nutrient/chemical run-off that can add to algae growth and sedimentation of the lake bottom.

To measure the impact of shoreline disturbance, the aquatic plant transects at sites with 100% natural shoreline were compared to aquatic plant transect sites at shoreline that contained any amount disturbance. The comparison of various parameters indicate that disturbance on the shore has negatively impacted the aquatic plant community at those sites.

The quality of the aquatic plant community (as measured by the AMCI) is higher at the natural shoreline communities. The natural shoreline communities supported better diversity in the plant community which will provide a more diverse habitat for more diverse wildlife and fish communities. The percent cover of submergent plant species is higher at natural shoreline sites and the maximum rooting depth is greater, providing a wider band of habitat. This is seen in the higher Simpson's Diversity Index and the greater Species Richness both overall and in all depth zones at natural shoreline sites (see figure 42).

Figure 42: Aquatic Macrophyte Community Index: Natural vs. Disturbed Shoreline Sites, 2005

Category	Natural	Disturbed
Maximum Rooting Depth	7	3
% Littoral Zone Vegetated	10	10
% Submergent Species	10	9
# of Species	8	8
% Exotic Species	6	6
Simpson's Diversity Index	8	7
% Sensitive Species	10	10
Totals	59	53

* The highest value for this index is 70.

Several parameters point to disturbance as the likely factor for the difference in the plant communities.

1) The most sensitive species in Patrick Lake (*Potamogeton praelongus*) (Nichols 2000) occurred at a higher frequency, grew at a higher density and had a higher dominance at the sites near natural shoreline. Conversely, the most tolerant species in Patrick Lake (*Typha latifolia)* was found only at disturbed shore sites.
2) The Average Coefficient of Conservatism was higher at the natural shoreline communities. The natural shoreline sites are less tolerant to disturbance than the average lake in the state and the disturbed shoreline sites are more tolerant to disturbance than the average lake in the state, this is likely due to selection by past disturbance.

3) The Floristic Quality Index is also higher at the natural shoreline sites. The natural shoreline sites are closer to an undisturbed condition than the average lake in the state and the disturbed shoreline sites are farther from an undisturbed condition than the average lake in the state.

Figure 43: Comparison of the Aquatic Plant Community at Natural Shoreline Sites and Disturbed Shoreline Sites.

Parameter		**Natural Shoreline**	**Disturbed Shoreline**
Simpson's Diversity Index		0.875	0.871
Species Richness (mean number of species per site)	Overall	3.17	2.89
	0-1.5ft Depth Zone	3.44	3.0
	1.5-5ft Depth Zone	3.22	3.0
	5-10ft Depth Zone	3.11	2.67
	10-20ft Depth Zone	2.0	0
Amount of Habitat	Maximum Rooting Depth	13 feet	7.5 feet
	% Cover of Submergent Species	96%	94%
Most Sensitive Species: *Potamogeton praelongus*	Overall Dominance	0.13	0.10
	Frequency	21%	17%
	Mean Density	0.45	0.28
Most Tolerant Species: *Typha latifolia*	Frequency	0	6%
Average Coefficient of Conservatism		6.23	5.91
Floristic Quality Index		23.31	21.33

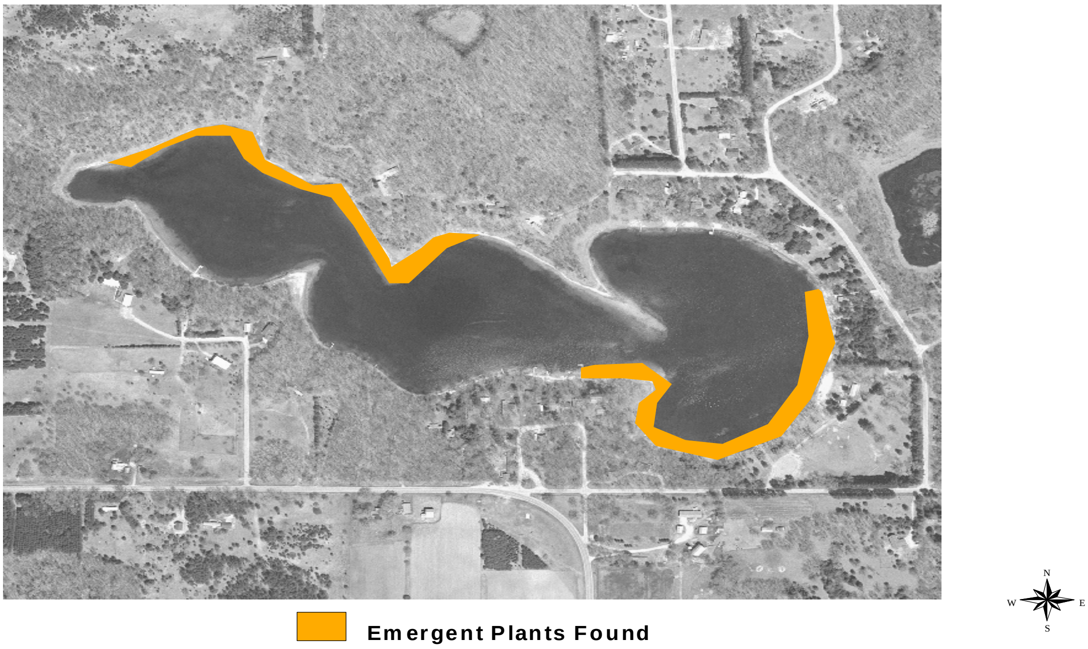
The assessments conducted in 1978 and 1983 were qualitative and the study conducted in 2005 was quantitative, so that direct comparisons of changes cannot be made, but some general information can be drawn from a mutual review. *Najas* spp. was still the most abundant species. *Potamogeton richardsonii* was still common, but *Potamogeton nodosus* was not found in 2005. *Chara* spp. was still present. In 2005, *Brasenia schreberi* still only occurred in one area of the lake, the northeast corner, but *Nymphaea odorata* is now found throughout the lake and not in just one area. Ten species that were found in 2005 were not mentioned in the 1978 survey.

Many differences between the 2002/04 and 2005 surveys can be attributed to the difference in timing during the growing season since aquatic plants reach their full growth in Mid-June to July. After the 2002, 2003 and 2005 treatments for Eurasian watermilfoil, the only species that showed significant changes (Cason and Roost 2004) were increases in *Elodea canadensis, Potamogeton crispus, Potamogeton illinoensis, Potamogeton zosteriformi*, as well as a significant decrease in *Myriophyllum spicatum.* The decrease in *Myriophyllum spicatum* was expected since the treatments were conducted to control this species. The increases in the other species are likely due to these species spreading and colonizing areas previously colonized by *Myriophyllum spicatum. Potamogetons* and *Elodea* are not impacted by the chemical used for *Myriophyllum spicatum.* There have been significant but temporary increases of *Elodea* on other lakes in the area after watermilfoil treatments.

Figure 44: Change in Aquatic Plant Species in Patrick Lake, 1978-2005.

Scientific Name	1978*	1983	July 2005
Emergent Species			
1) *Carex* spp.			Present
2) *Scirpus validus*	Common	Scattered	Scattered
3) *Typha angustifolia*		Scarce	Scarce
Floating-leaf Species			
4) *Brasenai schreberi*	Present	Present	Present
5) *Nuphar variegata*			Present
6) *Nymphaea odorata*	Present	Common	Abundant
7) *Polygonum amphibium*	Present		
Submergent Species			
8) *Chara* sp.	Present	Common	Sub-Dominant
9) *Elodea canadensis*	Common	Scarce	
10) *Myriophyllum* spp.	Common	Common	
11) *Najas guadalupensis*	Dominant	Abundant	Dominant
12) *Nitella* sp.		Scattered	Scattered
13) *Potamogeton amplifolius*		Scattered	Scattered
14) *Potamogeton gramineus*			Scattered
15) *Potamogeton illinoensis*			Common
16) *Potamogeton natans (nodosus?)*	Common		Scarce
17) *Potamogeton pectinatus*		Scattered	
18) *Potamogeton praelongus*		Scarce	Abundant
19) *Potamogeton richardsonii*	Common		Common

Figure 45a: Distribution of Emergent Plants in Patrick Lake 2005



RE:2/07

Figure 45b: Distribution of Floating-Leaf Plants in Patrick Lake 2005

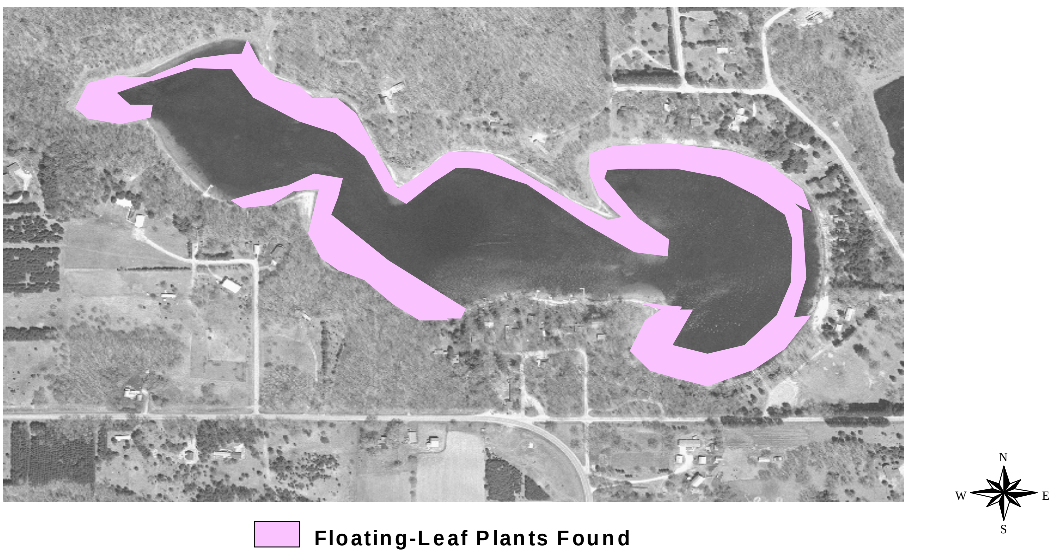


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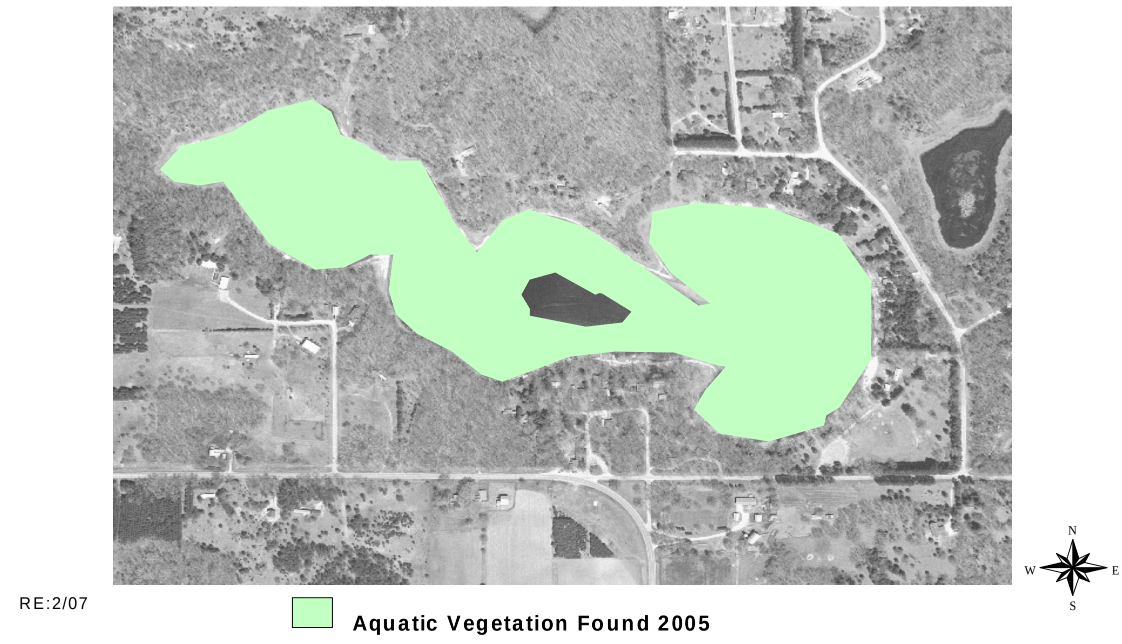
Figure 45c: Submergent Aquatic Plants in Patrick Lake 2005



Efforts at controlling aquatic plant growth have included both chemical treatments and some mechanical harvesting. Chemical treatment records go back to 1999. No harvesting records are available.

Figure 46

. Herbicide Treatments 1958-2005

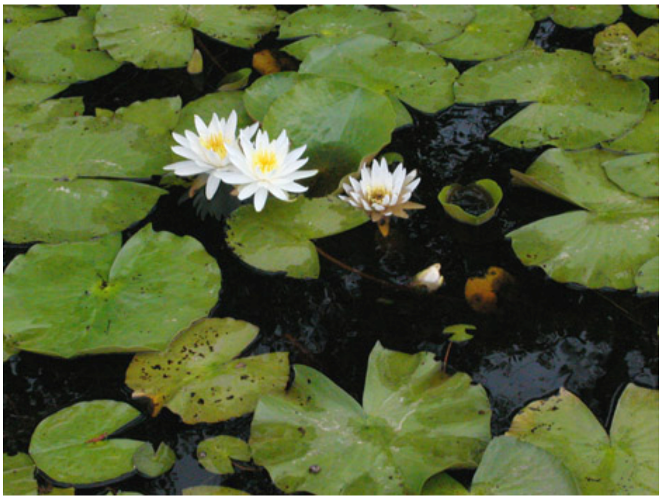
	Acres	Sodium Arsenite (lbs)	Hydrothol * (lbs)	Diquat (gal)	Cutrine (gal)	2, 4-D lbs.
1958	11.4	1100				
1959	11.5	1200				
1979	2.3		450			
1980	2			2	1	
1981	2.5			5	3	
1983	0.06					10
2005	17					1865
Totals		2300	450	7	4	1875

* Hydrothol is an endotahall product more damaging to young fish than Aquathol.

Chara spp
(Muskgrass)

Figure 47: Some Common Native Aquatic Species in Patrick Lake

Najas guadeulupensis
(Water Nymph or Southern Naiad)



Nymphaea odorata
(White Water Lily)

Potamogeton praelongus
(Flat-stemmed Pondweed)

Aquatic Plant Management Recommendations from 2005 Report

1) All lake residents shall practice best management on their lake properties. Keep septic systems cleaned and in proper condition, use no lawn fertilizers, clean up pet wastes and do not compost near the water or allow yard wastes and clippings to enter the lake;

2) Residents should resume involvement in the Volunteer Lake Monitoring Program;

3) Adams County to should designate sensitive areas within Patrick Lake.
    a. Lake residents protect natural shoreline around Patrick Lake to provide habitat and protect water quality in the lake. Disturbed shoreline (cultivated lawn and hard structures) is common, covering 20% of the shore. Comparison of the plant communities at natural shoreline and disturbed shoreline indicate that disturbance is already impacting the aquatic plant community and the habitat;

4) All lake users shall protect the aquatic plant community in Patrick Lake;

5) Lake District should maintain exotic species signs at the boat landings;

6) Lake Association shall continue monitoring Eurasian watermilfoil.
    a. Continue early-season treatments with a specific chemical on larger areas
    b. Hand pull scattered plants and small colonies.

Aquatic Invasives

Two aquatic invasive exotic plants have been found in Patrick Lake over the years: Eurasian Watermilfoil and Curly-Leaf Pondweed. Of the two, *Myriophyllum spicatum* (EWM, Eurasian Watermilfoil) has been the biggest problem in management of the lake. So far, it appears that native plants moved into much of the areas left vacant by chemical treatment of the Eurasian Watermilfoil. If this situation continues, EWM may be kept under control in Patrick Lake. In 2008, several lake citizens will be trained to monitor the aquatic invasives and participate in the Clean Boats, Clean Waters boater education program. This should assist in monitoring any recurrence of these invasives and also help the lakeowners watch for others. Although boat traffic has decreased substantially as the lake lost water, it may pick up again after the heavy snow in the winter of 2007-2008 and 2008 spring rains. Increased boat traffic, combined with the disturbance due to the large fluctuation in water levels, may substantially disturb the lake and make it more vulnerable to invasive growth.

Figure 48: Invasive Aquatic Plants known to have occurred in Patrick Lake

Potamogeton crispus
(Curly-Leaf Pondweed)

Myriophyllum spicatum
(Eurasian Watermilfoil)

Critical Habitat

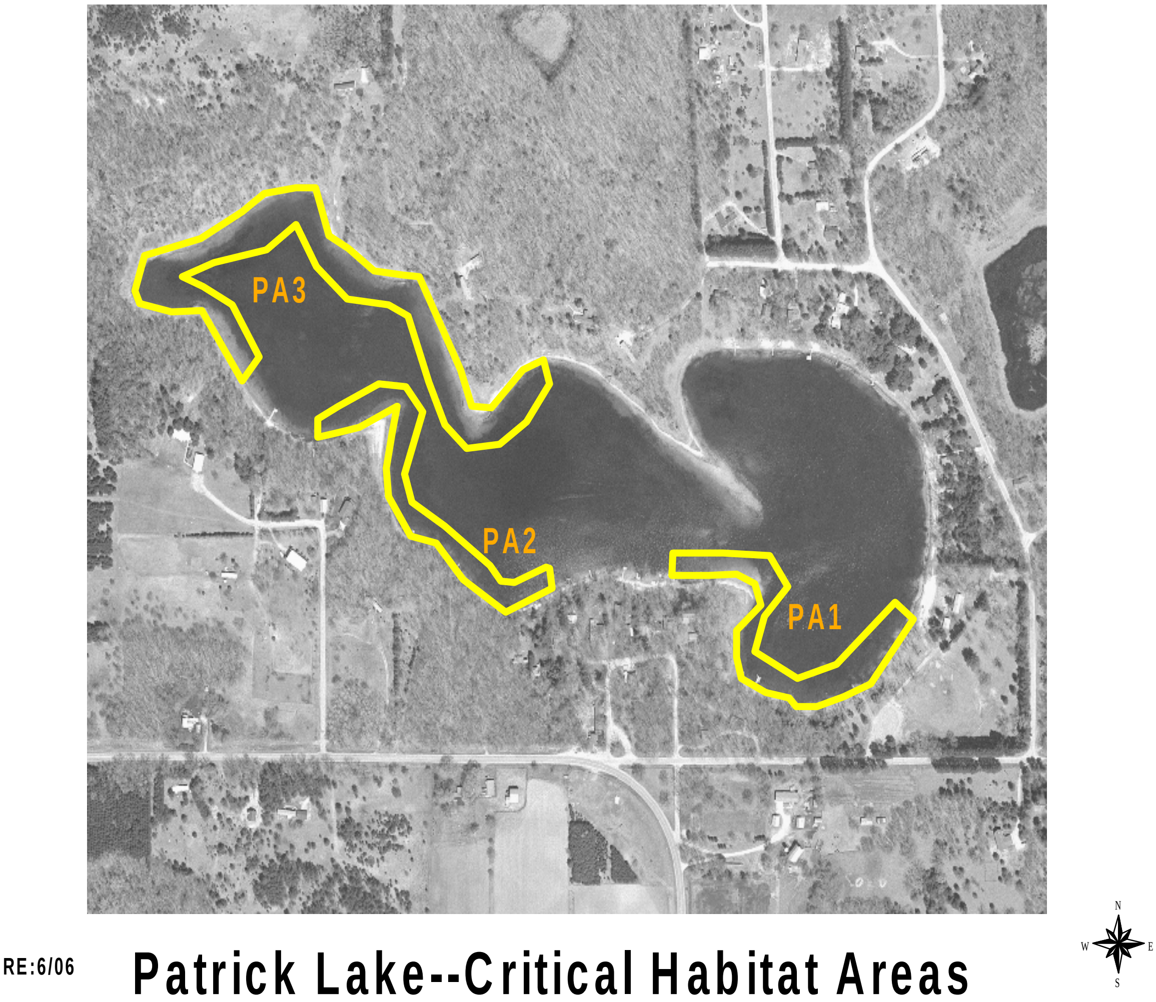
Designation of critical habitat areas within lakes provides a holistic approach for assessing the ecosystem and for protecting those areas in and near a lake that are important for preserving the qualities of the lake. Wisconsin Rule 107.05(3)(i)(I) defines a "critical habitat areas" as: "areas of aquatic vegetation identified by the department as offering critical or unique fish & wildlife habitat or offering water quality or erosion control benefits to the body of water. Thus, these sites are essential to support the wildlife and fish communities. They also provide mechanisms for protecting water quality within the lake, often containing high-quality plant beds. Finally, critical habitat areas often can provide the peace, serenity and beauty that draw many people to lakes.

Protection of critical habitat areas must include protecting the shore area plant community, often by buffers of native vegetation that absorb or filter nutrient & stormwater runoff, prevent shore erosion, maintain water temperature and provide important native habitat. Buffers can serve not only as habitats themselves, but may also provide corridors for species moving along the shore.

Besides protecting the landward shore areas, preserving the littoral (shallow) zone and its plant communities not only provides essential habitat for fish, wildlife, and the invertebrates that feed on them, but also provides further erosion protection and water quality protection.

Field work for a critical habitat area study was performed on May 31, 2006, on Patrick Lake, Adams County. The study team included: Scot Ironside, DNR Fish Biologist; Deborah Konkel, DNR Aquatic Plant Specialist; Patrick (Buzz) Sorge, DNR Lakes Manager, and Reesa Evans, Adams County Land & Water Conservation Department. Areas were identified visually, with GPS readings and digital photos providing additional information. Information was also sought from Jim Keir, DNR Wildlife Biologist, and Terry Kafka, DNR Water Regulation Specialist. Three areas on Patrick Lake were designated as "critical habitat areas".

Figure 49: Map of Critical Habitat Areas on Patrick Lake



Critical Habitat Area PA1

This area extends along approximately 800 feet of the shoreline. 70% of the shore is native herbaceous vegetation; 23.3% of the shore is cultivated lawn; the remaining shore is hard structure. There are downed logs in the water that provide fish and wildlife cover. Filamentous algae were found in this area. There is a moderate level of human disturbance at this area.

This area provides spawning and nursery areas for many types of fish: northern pike; largemouth bass; and several species of panfish. All of these fish also feed and take cover in these areas. No exotic fish or wildlife were noted in this area, i.e, no carp, smelt or rusty crayfish were seen. Geese and songbirds are known in this area of Patrick Lake, as well as reptiles and amphibians.

Maximum rooting depth of aquatic vegetation in PA1 was 5.5 feet. No threatened or endangered species were found here. Bulrush, an emergent plant, is found is this area. Emergents provide important fish habitat and spawning areas, as well as food and cover for wildlife. Aquatic vegetation at this site included 2 species of floating-leaf rooted plants and 7 species of submergent aquatic plants. A diverse submergent community provides many benefits. Curly-Leaf Pondweed, an exotic invasive plant, was found in this area. Most of the aquatic vegetation in this area has multiple uses for fish and wildlife. Because this site provides all three structural types of vegetation, the community has a diversity of structure and species that supports even more diversity of fish and wildlife.

Figure 50: Photo Showing Area PA1

Critical Habitat Area PA2

This area extends along approximately 1000 feet of the shoreline. 25% of the shore is wooded; 10% has shrubs; 45% is native herbaceous cover. The remaining shore is cultivated lawn and hard structure. Large woody cover is common in the shallow water for habitat.

This area of large woody cover, emergent aquatic vegetation, submergent and floating vegetation provides spawning and nursery areas for many types of fish: northern pike; largemouth bass; and several species of panfish. All of these fish also feed and take cover in these areas. No exotic fish or wildlife were noted in this area, i.e, no carp, smelt or rusty crayfish were seen.

Seen during the field survey were geese and songbirds. Upland wildlife is also known in this area. Downed logs serving as habitat were also seen. Frogs and salamanders are known to use this area for shelter/cover, nesting and feeding. Turtles and snakes also use this area for cover or shelter in this area, as well as nested and fed in this area. Although human disturbance is present in PA2, the area still provides quality habitat for many types of wildlife.

Maximum rooting depth in CR2 was 13 feet. No threatened or endangered species were found in this area. One exotic invasive, *Potamogeton crispus* (Curly-Leaf Pondweed), was found in this area. *Myriophyllum spicatum* had been found previously here. Most of the area had filamentous algae, especially near the shores. The plant-like algae, *Chara* spp was abundant in this area. There is a shortage of emergent plants in this area, which is unfortunate, since emergents provide important fish habitat and spawning areas, as well as food and cover for wildlife. One floating-leaf rooted plant species was found. The remaining 6 aquatic plant species were all submergents.

Figure 51: Photo of Part of PA2

CRITICAL HABITAT AREA PA3

This area extends along approximately 1650 feet of the shoreline. Sediment includes marl, muck, peat, sand, silt and mixtures thereof. 6.7% of the shore is wooded; 5% has shrubs; 85% is native herbaceous cover—the remaining is cultivated lawn. Large woody cover is present in shallow water for fish and wildlife cover. Scenic beauty in part of the area is lessened due to the human development.

This area does provide spawning and nursery areas for many types of fish: northern pike; largemouth bass; and several panfish species. All of these fish also feed and take cover in these areas. No exotic fish or wildlife were noted in this area, i.e, no carp, smelt or rusty crayfish were seen.

Seen during the field survey were geese, ducks and songbirds. Frogs and salamanders are known to use this area for shelter/cover, nesting and feeding. Turtles and snakes also use this area for cover or shelter in this area, as well as nesting and feeding in this area. Muskrats and mink are known to use this area. Upland wildlife feed and nest here as well.

Maximum rooting depth in PA3 was 7 feet. No threatened or endangered species were found in this area. *Chara* spp and filamentous algae were present in area PA3. Only one emergent species found in this area. One floating-leaf rooted plant was present here. 5 species of submergent aquatic species were found here. *Potamogeton crispus* was common here. Another exotic invasive, *Myriophyllum spicatum* (Eurasian watermilfoil), was previously found in this area.

Many of these plants are used by wildlife and fish for multiple purposes. Because this site provides all three structural types of vegetation, the community has a diversity of structure and species that supports even more diversity of fish and wildlife.

Figure 52: Photo of Part of PA3

Critical Habitat Recommendations

(1) Maintain current habitat for fish and wildlife.
(2) Do not remove fallen trees along the shoreline nor logs in the water.
(3) No alteration of littoral zone unless to improve spawning habitat.
(4) Seasonal protection of spawning habitat.
(5) Maintain snag/cavity trees for nesting.
(6) Maintain wildlife corridor in some areas and increase corridor in more developed areas.
(7) Establish shore buffers of native vegetation in areas now in cultivated lawn.
(8) Maintain no-wake zone.
(9) Protect emergent vegetation.
(10) Removal of submergent vegetation only and only for navigation in narrow channels.
(11) Seasonal control of Curly-Leaf Pondweed and Eurasian Watermilfoil if they reoccur.
(12) No use of chemicals for control of native vegetation.
(13) Minimize aquatic plant and shore plant removal by limiting removal to 30' wide access/viewing corridor. Leave as much vegetation as possible to protect water quality and habitat.
(14) Use best management practices in undeveloped areas on shoreline properties.
(15) No use of lawn products on shoreline properties.
(16) No bank grading or grading of adjacent land.
(17) No additional pier construction or other activity except by permit using a case-by-case evaluation.
(18) No installation of pea gravel or sand blankets.
(19) No bank restoration unless the erosion index scores moderate or high. Enforce 30'per 100' of shorefront for access corridor regulations.
(20) If the erosion index does score moderate or high, bank restoration only using biologs or similar bioengineering, with no use of riprap or retaining walls.
(21) Placement of swimming rafts or other recreational floating devices only by permit.
(22) Maintain buffer of shoreline vegetation where there is currently a buffer.
(23) Maintain aquatic vegetation buffer in undisturbed condition for wildlife habitat, fish use and water quality protection.
(24) Post "exotics alert" sign at boat ramp.

FISHERY/WILDLIFE/ENDANGERED RESOURCES

WDNR records show that Patrick Lake had a long history of fish winterkills, back to 1936, until an aeration system was installed in 1974. A chemical eradication of fish in the lake in 1962 revealed only yellow perch, black bullheads and bluegills. For reason unknown, largemouth bass & northern pike that had been stocked previously had apparently not survived. After the 1962 kill, stocking started again in 1963, and later inventories show that the lake included northern pike, largemouth bass, crappie and bluegills. Whatever the previously problem was for non-survival, apparently it didn't continue after the 1962 chemical eradication. Since 1963, fish inventories have found that largemouth bass continued to survive in the lake, as well as pumpkinseed, black bullhead, perch and bluegills. Pike continue to survive, but are scarce.

Muskrat are also known to use Patrick Lake shores for cover, reproduction and feeding. Seen during the field survey were various types of waterfowl and songbirds. Frogs and salamanders are known, using the lake shores for shelter/cover, nesting and feeding. Turtles and snakes also use this area for cover or shelter in this area, as well as nested and fed in this area. Upland wildlife feed and nest here as well.

Figure 53: Photo of Wetland Area on Patrick Lake shore

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